



Energy Efficiency Standards Group

Energy Technologies Area

Lawrence Berkeley National Laboratory

Dishwashers in the Residential Sector: A Survey of Product Characteristics, Usage, and Consumer Preferences

Hannah Stratton, Yuting Chen, Camilla Dunham, Thomas Burke,
Hung-Chia Yang, and Mohan Ganeshalingam

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1. INTRODUCTION

Data on consumer purchasing decisions, usage, and behaviors relating to residential appliances help to inform technical and economic analyses related to the energy and water used by those appliances, including dishwashers. Existing publicly available data for dishwashers include two regularly conducted national surveys that describe dishwasher ownership and usage. The United States (US) Department of Energy's (DOE) Energy Information Administration's Residential Energy Consumption Survey (RECS) records the presence of a dishwasher in the home, the numbers of times per week the dishwasher is operated, and the dishwasher age, along with household demographic characteristics.^{a,1} The US Census Bureau's American Housing Survey (AHS) also records the presence of a dishwasher in the home along with household demographic characteristics.^{b,2}

While these surveys provide necessary information for characterizing the national dishwasher stock, as well as usage, they do not lend insight to the value consumers place on energy efficiency relative to other product attributes when making their dishwasher purchase decisions. Information on consumer preferences and attitudes related to energy efficient dishwashers can both enable robust modeling of future energy consumption attributable to dishwasher use in the US, and shed light on the impacts of potential energy policies. We sought to fill gaps in the existing data regarding consumer selection of dishwashers and undertook a consumer survey to broaden available data on consumer purchase choices and operating behaviors as related to dishwasher and household characteristics (particularly for key demographic groups such as low-income and senior-only households). The purpose of this study is two-fold:

- First, this study gathered data on drivers of consumer dishwasher purchasing decisions. Understanding how consumers make trade-offs between product price, efficiency, and other product attributes can enable the modeling of purchasing behavior and help estimate future energy consumption from dishwasher use, as well as potential energy savings from energy efficiency improvements and policies.
- Second, the study collected data on dishwasher product characteristics that determine energy and water use, as well as consumer habits and behaviors relative to dishwasher usage and repair costs. This information can provide additional data for use in technical and economic analyses.

Section 2 of this report describes the consumer survey questionnaire, the method used to determine the sample, and the sample weighting approach. Section 3 reports on the relative importance of various dishwasher attributes, and examines two key attributes in dishwasher purchase decisions in greater detail: price and energy efficiency. Features of dishwasher purchases are discussed in greater detail in Section 4, along with repair frequencies and usage amounts by key demographics. Section 5 discusses key

^a RECS is a national sample survey of housing units that collects statistical information on the consumption and expenditures for energy in housing units along with data on energy-related characteristics of the housing units and occupants. The survey is conducted every 3 to 5 years and the most recent survey, 2015 RECS, has a sample size of 5,686 housing units. RECS was constructed by EIA to be a national representation of the household population in the United States. In 2015, approximately 67.5 percent of all US households had a dishwasher and, of those households, 80 percent use their dishwashers. (US DOE, 2015)

^b Conducted every other year, AHS is a comprehensive study of housing in the United States. The 2019 AHS, with a sample size of 63,185 households, showed dishwashers in 73.9 percent of households.

takeaways from this study. Three appendices include the survey instrument, additional dishwasher attribute trade-off exercise results, and additional general survey results, respectively.

2. METHODOLOGY

2.1 Overview

This study collected data for dishwashers purchased and used in residences in the US. We devised the general survey approach and content, and then engaged OSG Analytics^{c,3} to lead respondent recruitment and screening, survey dissemination, and compilation of initial survey results. Respondents completed the 30-minute online survey between May and June of 2019.

2.2 Survey Design

The online survey consisted of six sections: (1) screening questions to establish the initial survey sample, (2) respondent understanding of dishwasher features, (3) dishwasher ownership and usage details (4) dishwasher attribute prioritization using the Adaptive Self-Explication of Multi-Attribute Preferences (ASEMAPTM) method^{d,4}, (5) respondent preferences regarding dishwasher purchase and usage, and (6) a respondent demographics section. Section 2.2.1 provides more information on the general survey design, and Section 2.2.2 provides more detail on the ASEMAPTM method to identify consumer preferences of dishwasher features. See Appendix A for the full list of survey questions.

2.2.1 *General Questionnaire*

The online survey began with questions to screen for possible bias, and to ensure that the respondent qualified for the survey. These questions related to employment (e.g. working for an appliance manufacturer or utility), participation in other research studies (e.g. recent participation in energy-related studies), and other select criteria (e.g. was at least 18 years of age and played a role in the recent dishwasher purchase decision). Respondents were also screened based on how recently they had made their dishwasher purchase. Because the intent of the survey was largely to understand how consumers made dishwasher purchasing decisions, respondents were removed from the sample pool if they had not made a dishwasher purchase within the past five years, given that recollection of the purchasing decision may be diminished. While there could potentially be issues of recall bias, this threshold was set when balancing other needs for survey quality (e.g. ensuring an adequate sample size). Respondents who passed the initial set of screening questions were then presented with questions related to dishwasher type, purchase location preferences, satisfaction with their dishwasher, size of their dishwasher, familiarity with ENERGY STAR[®] and EnergyGuide labels, usage of their dishwasher, use of smart home technology, and repair costs.

The data collected from the general questionnaire advance the first goal of the survey: to collect data that describe the US dishwasher stock and consumer usage patterns with information not available in existing data.

^c OSG Analytics was selected to execute the survey in order to take advantage of their ASEMAPTM platform (described further in section 2.2.2 below), which was previously used to study lightbulb purchasing decisions for Pacific Gas & Electric (PG&E).

^d ASEMAPTM is a proprietary attribute trade-off exercise developed by OSG Analytics.

2.2.2 ASEMAP™ Exercise

ASEMAP™ is a trade-off methodology that measures customers' preferences by having respondents rank product attributes relative to one another. This exercise was included in the survey in order to obtain customer preference data that demonstrates the importance of various product attributes, including energy efficiency. Understanding the factors that drive purchase decisions for energy and water-consuming products is key to better understanding water and energy consumption trends generally.

ASEMAP™ uses a constant-sum paired comparison question (100-point allocation) approach to capture trade-offs between product attributes. When the product has multiple attributes, this approach enables respondents to assign an importance level for each attribute. This method also employs a dynamic algorithm, where subsequent paired comparisons are chosen automatically based on the respondent's answers to previous comparisons.

In this study, we used the ASEMAP™ methodology to better understand consumer preferences for the following dishwasher attributes (listed in alphabetical order):

- | | |
|---|---|
| 1. Brand | 11. Length of warranty offered by manufacturer |
| 2. Connected functionality | 12. Location of cutlery tray/basket |
| 3. Cycle time (for typical cycle selection) | 13. Number of racks |
| 4. Dishwasher exterior material | 14. Pre-wash requirements |
| 5. Dishwasher interior material | 15. Purchase price of the dishwasher |
| 6. Dishwasher sound when in use | 16. Types of wash cycles available |
| 7. Dishwasher style/type | 17. User reviews and feedback of the dishwasher |
| 8. Energy bill cost savings | 18. Water consumption of dishwasher |
| 9. Energy efficiency of dishwasher | |
| 10. ENERGY STAR® label | |

The ASEMAP exercise was conducted in a series of steps:

1. Respondents reviewed a list of 18 attributes that they may consider in their dishwasher purchase. Respondents were asked to review the full list of attributes and choose the 6 that were most important to them when choosing a dishwasher for their home. Those attributes were then removed from the list, and respondents were asked to identify the next 6 most important attributes. Once respondents had identified these attributes, they were asked to rank these 12 from most important to least important.
2. Respondents completed a comparison exercise, during which they were presented with two attributes from the pool of attributes they had previously chosen, and were asked to indicate which one was "more important," as well as indicate how much more important that chosen attribute was to the one it was being compared to.
3. Respondents were asked to indicate how desirable various possibilities were for a given attribute to examine the relative sensitivity to different levels within an attribute.
4. Respondents were presented with multiple dishwashers with a given combination of attributes from the list above and asked to indicate how likely they were to purchase a dishwasher for their home..

The data collected from the ASEMAP™ exercise advance the second goal of the survey: to collect information that describes the consumer preferences related to dishwasher attributes.

2.3 Sampling Methodology

We identified a target sample size of 1,200 qualified respondents. This sample size was chosen as it corresponds to a sampling error of approximately 2.8 percent, which was deemed acceptable. OSG used an online consumer panel to obtain a sample of 1,200 qualified respondents.

Participants in the survey were initially screened based on the following criteria:

- Must not have been employed or had an immediate family member employed by a marketing or market research department/company, electric utility, gas utility, or household appliance manufacturer, and must not have worked in public relations within the last 12 months
- Must not have participated in market research studies related to power, electricity, or household appliance purchases within the last three months
- Must be 18 years of age or older
- Must live in a mobile home, single-family house, or an apartment
- Must use a dishwasher currently
- Must have purchased a dishwasher within the last five years
- Must have had a role in the decision-making process for the recent dishwasher purchase

Initially, 5,013 respondents responded to at least one question of the survey. Of the 5,013 total respondents, 3,110 respondents (62 percent) completed the entire demographic section. This sample of 3,110 respondents was used to perform the weighting of the final sample and is referred to as the “contact sample.” From the contact sample, 1,073 respondents (35 percent) did not meet the screening criteria described above, and an additional 809 respondents (26 percent) did not fully complete the survey. This resulted in a sample of 1,228 respondents who met the screening criteria and completed the full survey.

Data from these 1,228 respondents were examined to exclude any responses deemed unreliable. We flagged and excluded data from respondents that did not appear to be taking the survey with full attention. One criterion defined the time the respondent spent taking the survey compared to the expected survey time: responses were discarded if the respondent’s total survey response time was less than one-third of the expected survey time (10 minutes). Other criteria included responses with a negatively correlated score within the ASEMAPTM section,^e or illogical responses to open-ended questions (e.g. random words or randomly typed characters – rather than an intentional response in the response fields). Of the 1,228 responses that met the initial screening criteria and completed the survey, 27 responses (2.2 percent) were excluded due to poor-quality responses and were not included in the subsequent analysis. Therefore, the final sample included 1,201 respondents (24 percent of the initial 5,013 respondents). The final sample of

^e Negatively correlated scores in ASEMAP refer to inconsistent responses during the ASEMAP exercise – e.g. ranking an attribute as a top priority in one exercise, and in the next exercise ranking it towards the bottom.

1,201 respondents will be referred to as the “complete sample” henceforth.

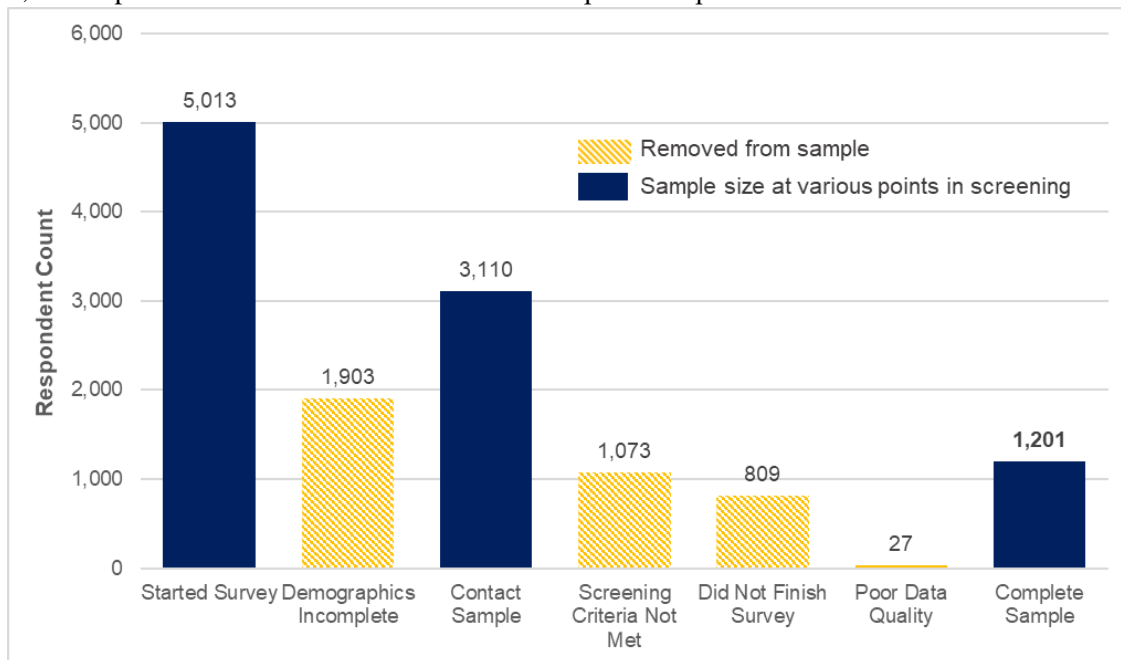


Figure 2.1 provides a visual representation of how many respondents were rejected in each stage of the screening process.

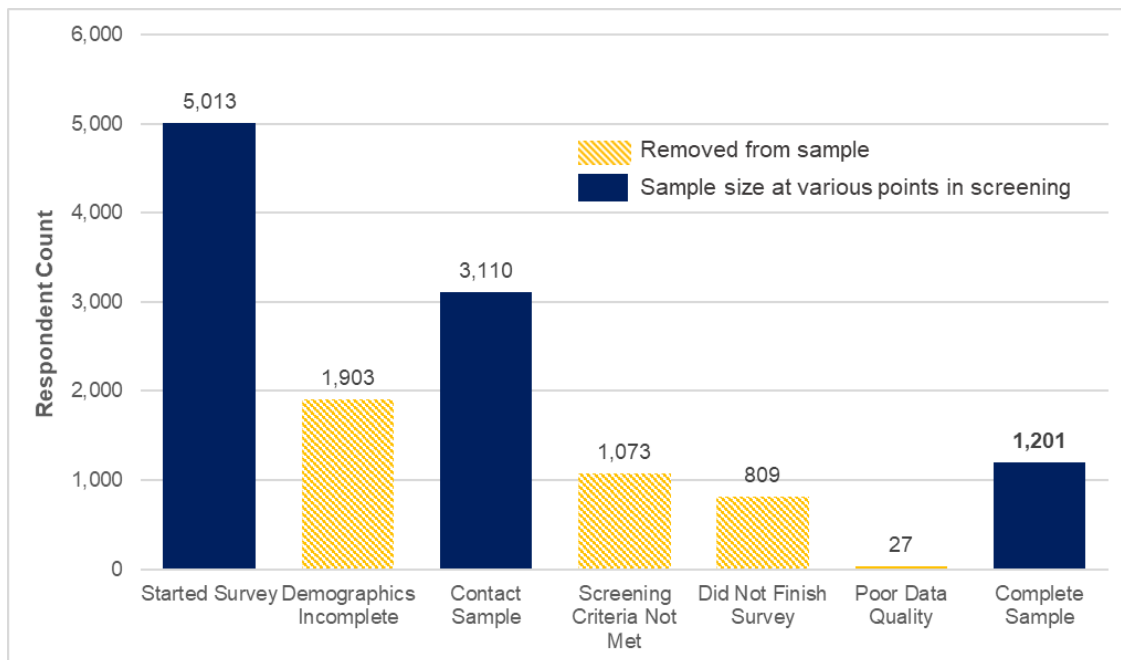


Figure 2.1. Dishwasher Sample Determination

An online survey was chosen given it is an efficient method to reach respondents across a wide geographic range. However, we acknowledge that solely utilizing this method could result in potential sample bias. For this reason, we employed the weighting approach described in section 2.4 below in an

effort to achieve a sample that was as nationally representative as possible, though some degree of sample bias may persist.

2.4 Weighted Sample

We sought to ensure that the sample was as reflective of the US population (in terms of demographics such as age, income, etc.) of recent purchasers of dishwashers as possible. To this end, weights were developed for each respondent household based on the 2017 American Community Survey (ACS 2017), and then adjusted based on the 2015 Residential Energy Consumption Survey (RECS 2015). Results presented in this report use the weighting methodology described in section 2.4.1 below. Section 2.4.2 below presents results for different demographics for both the initial and weighted sample. While we aimed to make our study results as representative of the US population as possible, using the method described below, we do not assert that our results are perfectly nationally representative.

2.4.1 *Weighting Methodology*

The complete sample of 1,201 respondents was weighted to be representative of the population of consumers who purchased a dishwasher within the last 5 years. The weighting was accomplished by first comparing the contact sample (3,110 respondents) with the US population of adults as measured by the 2017 American Community Survey (ACS 2017) for six demographic variables: age, annual household income, education, marital status, ethnicity, and gender.^f A Random Iterative Method (RIM) approach was used to weight the contact sample so that it aligned with the ACS 2017 population. RIM is an iterative target weighting process, in which software applies multiplicative weights in an attempt to adjust data to a particular target (e.g. 50 percent female and 50 percent male). As the iterations are applied, the data moves closer to the target weight. The iteration process passes through each of the variables before beginning the next iteration. Typically there is a limit on the number of iterations that can be performed in order to avoid skewing data, and it is possible that not all targets will be achieved. Weights were initially computed for each demographic characteristic and were then multiplied to derive a composite weight across all six demographics variables. Both individual and composite weights were constrained to be within 0.40–5.13^g to avoid overweighting certain demographic groups and to ensure that all respondents were represented in the results. The final set of weighting parameters were mapped onto the complete sample of 1,201 respondents.

Additional minor weighting adjustments were performed to compare the 1,201 respondents in the complete sample to the subset of households who own a dishwasher that is less than 4 years old from the US Energy Information Administration's 2015 Residential Energy Consumption Survey (RECS 2015).^{h,1} Weights were calculated using the RIM weighting process to align the sample with RECS 2015 across

^f Conducted every year, ACS is a study of housing in the United States. <https://www.census.gov/programs-surveys/acs>

^g As a good weighting practice, weights are usually constrained from 0.5 to 2.5 so that the data is not leveraged on one or a few respondents. While keeping to the suggested norms, our contact sample data was further off the census proportions. To help ensure results were as good a representative of the U.S. population as possible, the upper constraint was intermittently increased, so the survey sample would align with the census and RECs data to an acceptable extent. The increased caps on the weights is not expected to be detrimental given no multi-variate analyses are performed and reporting is broadly descriptive.

^h RECS 2015 binning of dishwasher age differed from the binning used in our survey. Dishwashers in RECS 2015 less than 4 years old were most comparable to the complete sample in our survey (which represents dishwashers that are less than 5 years old).

income, ethnicity, education, age and gender, without compromising alignment of the contact sample with the US demographics as reported by ACS 2017.

2.4.2 Weighting Results

The weighting analysis results for the complete sample of 1,201 respondents are presented in Table 2.1 through

Table **2.7** below. The tables show the distribution of respondents for the survey group for the contact sample, the complete sample, and the weighted responses that were ultimately used in this analysis. Additionally, ACS 2017 and RECS 2015 are provided. Generally, it is expected that the contact sample would more closely resemble ACS 2017, and the weighted responses would more closely represent RECS 2015. While there are still some deviations between our samples and these two surveys (for example, the discrepancy between the 65+ age category for RECS 2015 and the weighted responses), the weighted responses are generally more aligned with RECS 2015 than the initial contact sample.

Table 2.1. Age distribution

Age	All Respondents				
	Contact Sample	ACS 2017	Complete Sample	RECS 2015	Weighted Responses
18-24 years of age	1%	13%	1%	6%	5%
25-34 years of age	7%	18%	7%	16%	20%
35-44 years of age	12%	16%	16%	16%	18%
45-54 years of age	16%	17%	22%	18%	24%
55-64 years of age	25%	16%	25%	16%	18%
65+ years of age	39%	19%	29%	29%	16%

Table 2.2. Total annual household incomeⁱ

Income	All Respondents			
	Contact Sample	ACS 2017	Complete Sample	Weighted Responses
Less than \$15,000	3%	11%	1%	5%
\$15,000 - \$24,999	4%	9%	2%	5%
\$25,000 - \$34,999	6%	9%	3%	7%
\$35,000 - \$49,999	10%	12%	8%	12%
\$50,000 - \$74,999	20%	17%	18%	19%
\$75,000 - \$99,999	16%	12%	20%	15%
\$100,000 - \$149,999	20%	13%	26%	20%
\$150,000 - \$199,999	8%	5%	11%	8%
\$200,000 or more	7%	6%	9%	7%
Prefer not to answer	6%	5%	3%	3%

ⁱ Due to different income categorizations and space constraints, RECS results are presented separately.

Table 2.3. Total annual household income

All Respondents	
Income	RECS 2015
Less than \$20,000	15%
\$20,000-\$39,000	21%
\$40,000 - \$59,999	15%
\$60,000 to \$79,999	14%
\$80,000 to \$99,999	9%
\$100,000 to \$119,999	8%
\$120,000 to \$139,999	5%
\$140,000 or more	13%

Table 2.4. Level of education

Level of Education	All Respondents				
	Contact Sample	ACS 2017	Complete Sample	RECS 2015	Weighted Responses
Some high school	1%	7%	0%	2%	1%
High school/GED	12%	29%	9%	19%	21%
Some college	18%	19%	17%	33%	22%
Associate degree	9%	10%	8%		8%
Bachelor's degree	35%	20%	36%	26%	28%
Graduate degree	25%	11%	29%	20%	20%

Table 2.5. Marital status distribution^j

Marital Status	All Respondents			
	Contact Sample	ACS 2017	Complete Sample	Weighted Responses
Married / Living with partner	69%	49%	79%	62%
Single	14%	34%	10%	27%
Divorced / Separated	6%	11%	8%	6%
Widowed	10%	6%	4%	4%

Table 2.6. Ethnicity distribution^k

Racial Identity	All Respondents				
	Contact Sample	ACS 2017	Complete Sample	RECS 2015	Weighted Responses
White	85%	61%	89%	73%	69%
Hispanic or Latino	2%	17%	4%	11%	13%
Black or African--American	4%	12%	3%	9%	11%
Asian	4%	5%	4%	4%	7%
American Indian / Alaska Native	1%	1%	1%	1%	1%
Other	1%	2%	1%	2%	1%

^j RECS 2015 did not collect data on marital status.^k Respondents were allowed to choose more than one option leading to column totals potentially summing to more than 100 percent.

Prefer not to answer	1%	1%	1%	0%	1%
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Table 2.7. Gender distribution

Gender	All Respondents				
	Contact Sample ¹	ACS 2017	Complete Sample	RECS 2015	Weighted Responses
Female	49%	49%	52%	53%	51%
Male	50%	51%	48%	47%	49%

3. ASEMAP RESULTS: CONSUMER PURCHASE DRIVERS

Section 3.1 summarizes the ranking results for dishwasher attributes from the ASEMAP exercise, which signify the level of importance of a given attribute in the purchase decision relative to other attributes (see steps 1 and 2 as outlined in section 2.2.2). Section 3.2 presents results for the preference curves, which indicate preferences for the options within a single attribute (see step 3 in section 2.2.2).

3.1 ASEMAP™ Attribute Ranking

In the ASEMAP™ section of the survey, respondents indicated which attributes were most important when making a dishwasher purchase decision out of those listed in section 2.2.2. These attributes were thought to potentially matter to consumers in their dishwasher purchase decision based on product reviews and other relevant literature. Some of these attributes are directly related to energy consumption, whereas others provide useful context for understanding other considerations and tradeoffs consumers make in their purchase decision.

Each attribute selected by a respondent received a score depending on the level of importance the respondent assigned that attribute relative to the other attributes. The ASEMAP™ scores are indexed to 100. A score of 100 is considered to be of average importance amongst all of the possible purchase attributes. An attribute with a score of 200 means that attribute is twice as important as one that has a score of 100. Statistical significance between driver scores depends on the sample size of respondents. As sample size decreases, the difference needed for results to be considered statistically significant increases. Statistical significance for each attribute was determined by:

1. Calculating the mean ASEMAP values for each attribute across the sample.
2. Re-indexing the ASEMAP values by dividing by the mean of the mean ASEMAP values and multiplying by 100 ensuring that the average attribute corresponds to 100.
3. Calculating the significance at 95% as the standard deviation of the mean re-indexed ASEMAP values, divided by the square root of the sample size and multiplied by 1.96.

The attributes are sorted in descending order of their preference index in Figure 3.1 below. Purchase price, noise level when the dishwasher is in operation, and style/type of the dishwasher were chosen as the top three attributes that mattered to respondents in their dishwasher purchase. Brand, energy efficiency, and energy bill cost savings were the next most important attributes, followed by user reviews and feedback, exterior material, and length of the warranty. If any two drivers are separated by more than

¹ Note that the contact sample does not add up to 100% given the inclusion of “prefer not to answer” and “other” options, which was not included in the other surveys.

6 points in their ASEMAP score, it is considered statistically significant at the 95% confidence level. For example, we observe a statistically significant difference between purchase price of the dishwasher and dishwasher sound when in use, but do not observe a statistically significant difference between brand and energy efficiency of the dishwasher.

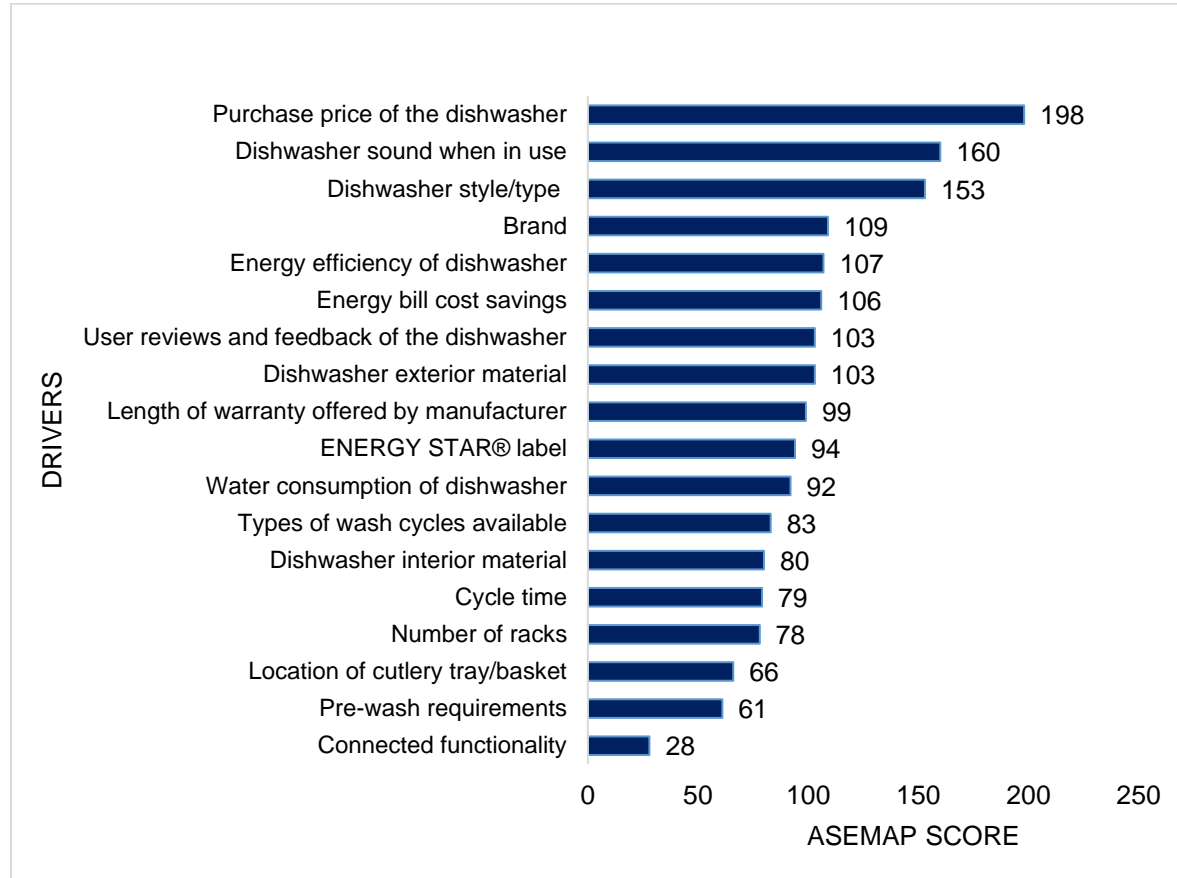


Figure 3.1 Dishwasher Purchase Drivers Sorted by ASEMAP™ Score, N=1,201

3.2 ASEMAP™ Preference Curves

Based on the ASEMAP™ results, consumer preference curves by various demographic features can be obtained. As stated in the previous section, the consumer preference is measured by an index for different attributes. The preference index reflects consumers' sensitivity towards different options available for a given product attribute (e.g., various purchase prices). Note that when comparing two product options, the difference only exists in the variable of interest, independent to all the other attributes which remain identical. The preference index ranges from zero to 100 and indicates the relative level of preference of consumers for one attribute option over another. The index can be interpreted as the fraction of consumers opting for a particular attribute option over a base option, which is usually considered as the option that is least preferred by the consumers.

$$I = 100 \times (P_{testing} - P_{base})$$

With the condition that

$$P_{testing} + P_{base} = 1$$

Where:

I	=	the preference index,
$P_{testing}$	=	$\frac{N_{testing}}{N_{total}}$, the probability of choosing the testing option, with
$N_{testing}$	=	number of consumers that choose the testing option,
N_{total}	=	total number of consumers, and
P_{base}	=	the probability of choosing the base / reference option.

A preference index (I) value of 100, indicates that 100 percent of consumers would prefer the testing option over the base option, while an I value of 20 implies that 60 percent of consumers would choose the testing option and the remaining 40 percent of consumers would prefer the base option. The ASEMAP™ preference curves for 2 of the 18 attributes that were tested are described further in this section: purchase price and energy efficiency. Given the relatively similar results that we obtained for energy efficiency and energy bill cost savings, we choose to explore only energy efficiency, which can be translated as consumption reduction for consumers. These attributes were explored further given the implications that they have on dishwasher energy consumption, cost, and their utility in consumer choice models.

Given the small sample sizes of various respondent subgroups relative to the entire survey, the results in the following sections have not been deemed statistically significant. The results still provide useful insight into dishwasher attribute preferences among various consumer subgroups, however.

3.2.1 *Purchase Price*

As shown in Figure 3.1 above, purchase price is the most important driver for respondents in their purchase decision. Figure 3.2 displays the preference curves for dishwasher purchase price (shown from lower to higher prices) by income group.

For households with income ranging from \$25,000 to \$199,999, a \$500 purchase price is the most-preferred option. Households that earn less than \$25,000 annually prefer the lowest-price option (\$250).^m Households earning \$200,000 or more annually indicated equal preference for purchase prices of \$500 and \$750.

^m The two lowest income groups (households making less than \$15,000 annually and those making between \$15,000 and \$24,999) were combined to obtain a larger sample size.

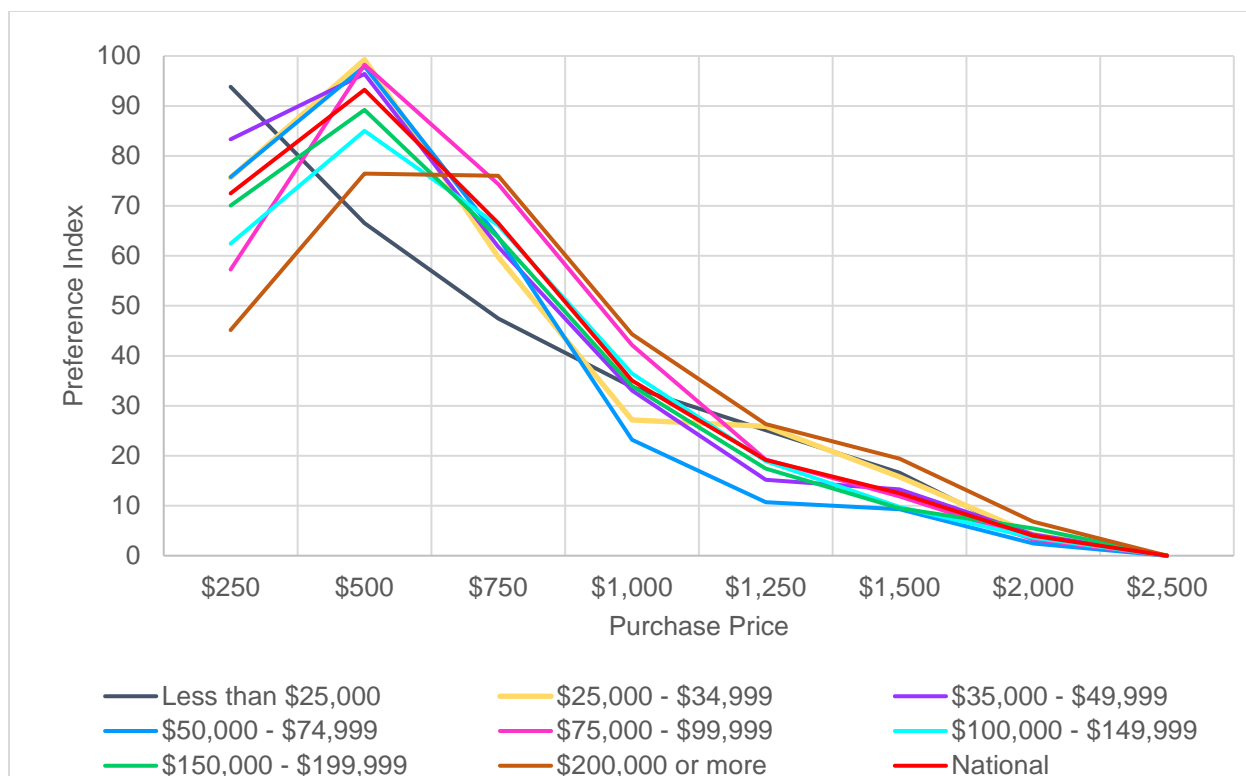


Figure 3.2. Purchase price preference for households grouped by income bins

Table 3.1. Weighted and unweighted sample size for income bin included in the ASEMAP™ preference curve analysis

Less than \$25,000	\$25,000 - \$34,999	\$35,000 - \$49,999	\$50,000 - \$74,999	\$75,000 - \$99,999	\$100,000 - \$149,999	\$150,000 - \$199,999	\$200,000 or more	Prefer not to answer	Total (N)
Sum of Sample weights									
108	78	147	222	181	244	99	87	35	1,201
Sample Counts									
34	39	95	216	239	307	126	105	40	1,201

To evaluate the impact on groups or consumers who may be disproportionately affected by any national energy conservation standards, we focused on two particular consumer groups: households that meet the Census Bureau's poverty definition of 100 percent below the poverty line (low-income households)ⁿ and households occupied only by residents older than 64 years of age (senior-only households). Therefore, in our analysis, preference curves for low-income households and senior-only households are examined separately from the national average in order to understand possible variation for these two consumer subgroups. Definitions for both the low-income and senior-only subgroups are provided in Table 3.2. Figure 3.3 displays the preference curves for dishwasher purchase price for these subgroups (shown from lower to higher prices) by income group. Results indicate the cheapest purchase price option (\$250) as the most desirable for the low-income group, and the second cheapest purchase price option (\$500) for the

ⁿ Low-income household residents are living at or below the poverty line. The poverty line varies with household size, age of head of household, and family income.

senior-only subgroup and national sample. Preferences for both subgroups then exhibited a downward trend as purchase price options incrementally increased.

Table 3.2. Low-income and senior-only subgroup criteria

Income group	Considered as low-income if:
Less than \$15,000	All households
\$15,000 - \$24,999	Household size > 1
\$25,000 - \$34,999	Household size > 4
\$35,000 - \$49,999	Household size > 6
\$50,000 and above	None
Age group	Considered as senior-only if:
Age <65	None
Age ≥65	For all household members



Figure 3.3. Purchase price preference by consumer subgroups

Table 3.3. Weighted and unweighted sample size for subgroups included in the ASEMAP™ preference curve analysis

Senior	Low-income	Total (N)
Sum of Sample weights		
177	98	275
Sample Counts		
290	31	321

3.2.2 Energy Efficiency

This section discusses the importance of the energy efficiency driver by different demographics and consumer behaviors, including household income group, household size, frequency of use, and the low-income and senior-only subgroups.

As household income declines, higher value is placed on reductions in energy consumption (see Figure 3.4). The preference for a reduction in energy consumption also increases as household size (defined as the number of household members) increases (see Figure 3.5). Figure 3.6 shows the relationship between the frequency of dishwasher use and preference for reductions in energy consumption. The sample size, weighted and unweighted, are provided in Table 3.4 and Table 3.5. Results show that reduction in energy use per cycle appears to be less important for respondents that run their dishwasher frequently than

respondents that operate their dishwashers less frequently.^o One might expect that those who run their dishwasher more frequently would value reductions in per cycle energy consumption more highly, as each cycle represents an incremental savings opportunity. However, it is possible that respondents who use their dishwasher less frequently do so from a desire to reduce energy consumption, therefore they showed a higher preference to all the energy saving options than the other frequency groups. Figure 3.7 suggests that both the low-income and the senior-only households are more likely to prefer all energy efficiency improvement options compared to the national average. Moreover, the low-income subgroup has a higher preference rate than the senior-only subgroup and national average for low energy efficiency improvement (10 percent energy reduction option).

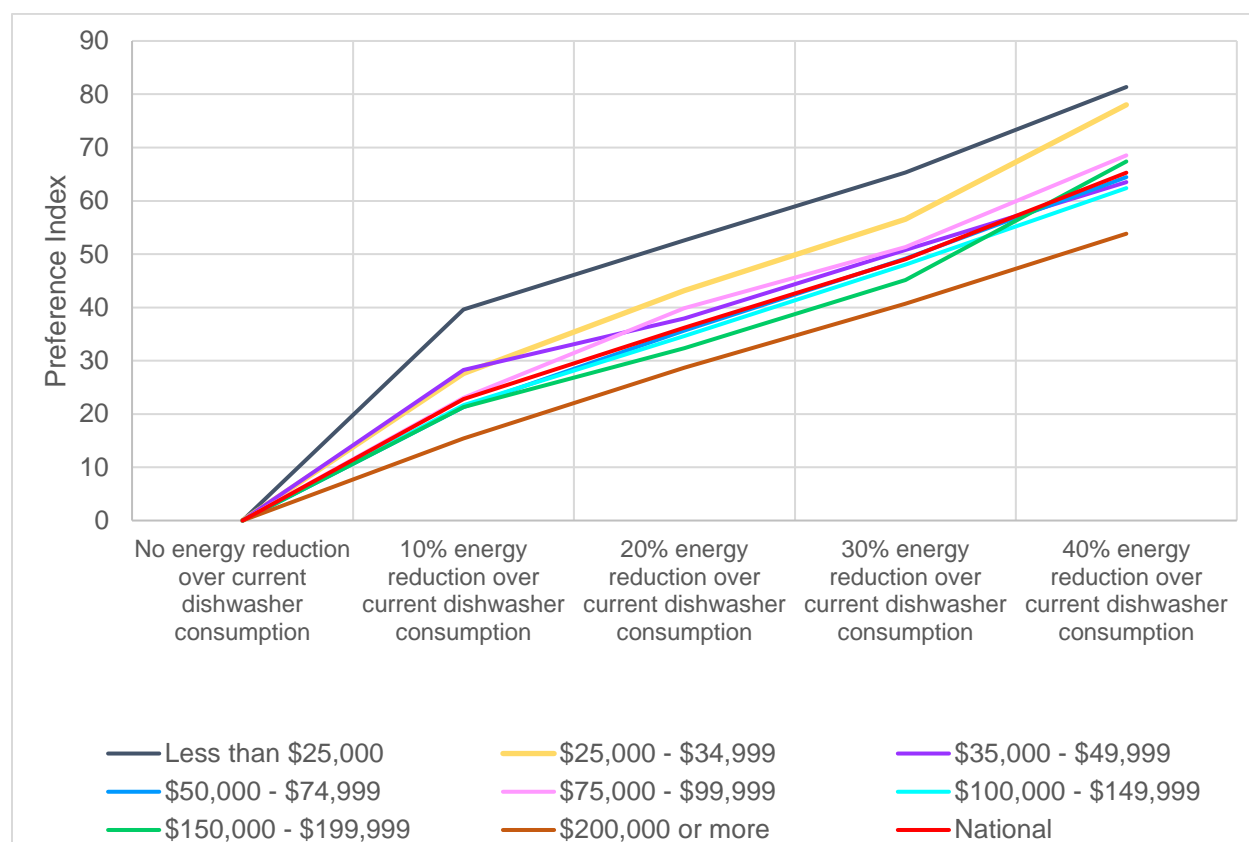


Figure 3.4. Energy consumption preference by income bin^p

^o While it is established that larger households tend to use their dishwashers more in Figure 4.10, because of their relatively small sample size they do not have much weight as compared to other household sizes in the groups that reported using their dishwasher more frequently.

^p See Table 3.1 for sample sizes.

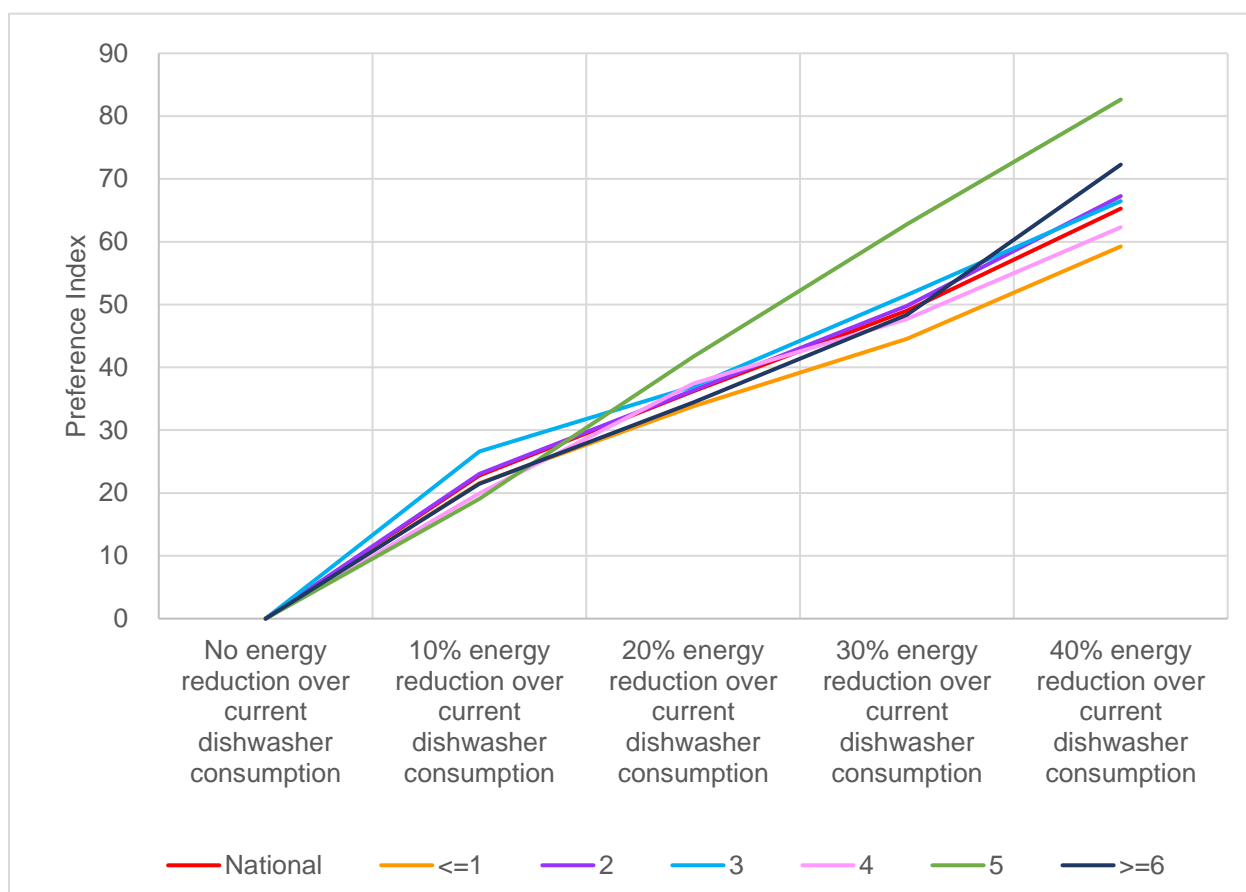


Figure 3.5. Energy consumption preference by household size

Table 3.4. Weighted and unweighted sample size for households of different sizes included in the ASEMAP™ preference curve analysis

<=1	2	3	4	5	>=6	Total (N)
Sum of Sample weights						
270	396	253	189	43	50	1,201
Sample Counts						
186	560	222	166	36	31	1,201

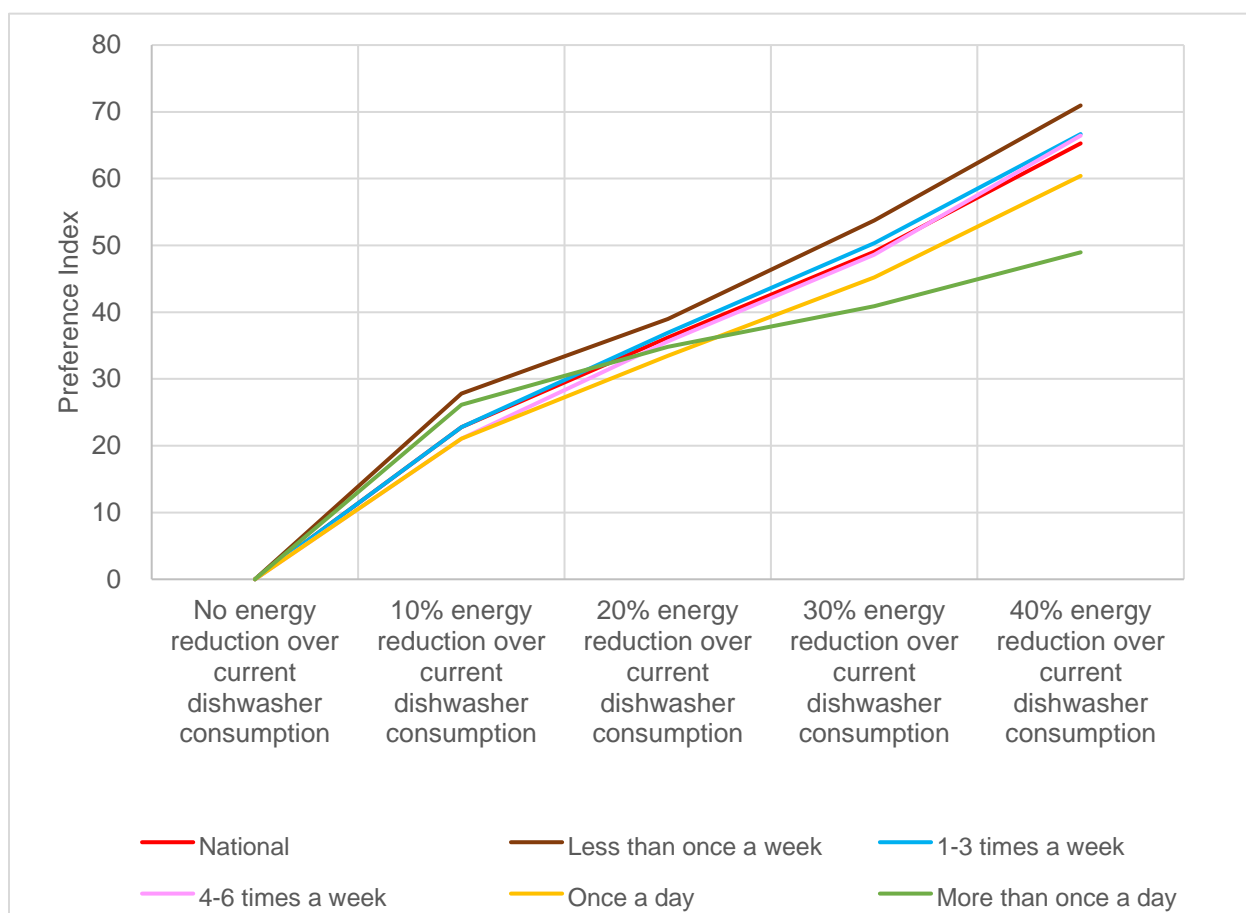


Figure 3.6. Energy consumption preference by frequency of use

Table 3.5. Weighted and unweighted sample size for households of different usage frequency included in the ASEMAP™ preference curve analysis

Less than once a week	1-3 times a week	4-6 times a week	Once a day	More than once a day	Total (N)
Sum of Sample weights					
125	549	281	193	53	1,201
Sample Counts					
107	598	305	161	30	1,201

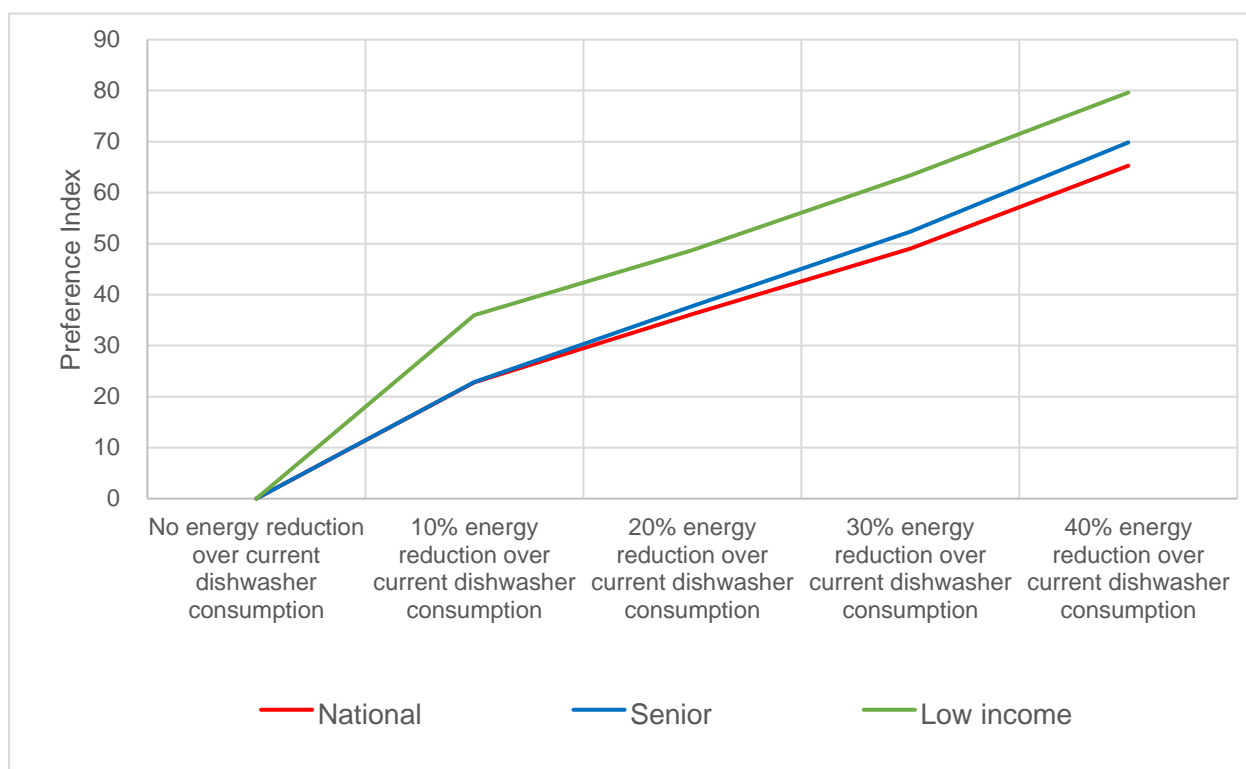


Figure 3.7. Energy consumption preference by consumer subgroups^q

4. GENERAL SURVEY RESULTS

This section presents results from the survey on product characteristics for recent dishwasher purchases, repair frequencies, and consumer usage behaviors that influence dishwasher energy consumption. See Appendix C for additional results from the survey on the complete set of questions.

For recent dishwasher purchases (Section 4.1), seven topics are explored: purchase reason, purchase location, dishwasher type, dishwasher size, dishwasher brand, wireless internet connection, and the influence of energy efficiency labelling in the purchase decision. Dishwasher repair frequency is discussed in Section 4.2, and dishwasher usage by householder demographics and consumer behavior is discussed in Section 4.3.

Although the complete sample has 1,201 respondents, for some survey results the sample size is less than 1,201 due to non-responses and/or inapplicability for respondents. Sample sizes for each query are provided below tables or figures of individual results. All results presented below use the weighting as outlined in Section 2.4. The results below were not determined to be statistically significant, but nevertheless provide useful insight into dishwasher purchases and usage in the US.

4.1 Recent Dishwasher Purchases

This section presents data on the stated reasons for the respondent's recent dishwasher purchase, as well as dishwasher product characteristics—including the dishwasher type, width, presence of an ENERGY

^q See Table 3.3 for sample sizes.

STAR® label, and presence of a smart feature. These data can enable greater understanding of dishwasher purchase drivers.

4.1.1 Reason for Dishwasher Purchase

Respondents were asked to identify the primary reason for their most recent dishwasher purchase. Results are presented in Table 4.1.

The most common reason for a dishwasher purchase was that the old dishwasher did not work and could not be fixed (31 percent). The next most common reason was that the old dishwasher required repair service, but that the respondent chose to purchase a new dishwasher instead (26 percent). Other reasons for purchase included remodeling the kitchen (16 percent), moving to a new home (15 percent), and wanting to replace an old dishwasher despite the current dishwasher still being functional (10 percent). Two percent of respondents indicated that they wanted an additional dishwasher in their home.

Table 4.1. Reason for most recent dishwasher purchase (weighted)

Reason for Recent Purchase	Percent of Respondents N=1,201
My old dishwasher didn't work and couldn't be fixed	31%
My old dishwasher required repair service, but I chose to buy a new dishwasher instead	26%
I remodeled my kitchen	16%
I moved to a new home	15%
My old dishwasher was still functional, but I wanted a new dishwasher	10%
I wanted an additional dishwasher	2%
Other	0%

4.1.2 Dishwasher Purchase Channel

Respondents were asked how (and where) they purchased their dishwasher. The majority (87 percent) of respondents purchased their dishwasher themselves, while 13 percent purchased their dishwasher through a contractor/builder. See Table 4.2.

Table 4.2 Dishwasher purchase channel (weighted)

How Respondents Purchased their Dishwasher	Percent of Respondents N=1,201
Purchased dishwasher themselves	87%
Purchased through contractor/builder	13%

Respondents were asked to indicate which of the following channels best represented their recent dishwasher purchase. Results are shown in Table 4.3 . The majority (82 percent) of respondents purchased their dishwasher from a retail store. Other responses included an online purchase from a retail store's website (12 percent), purchasing directly from an online retailer (3 percent), and purchasing through another source (2 percent).

Table 4.3 Dishwasher purchase location (weighted)

Dishwasher Purchase Location	Percent of Respondents N=1,201
From a retail store	82%

Dishwasher Purchase Location	Percent of Respondents N=1,201
Online – from a retail store’s website	12%
Online retailer (i.e. Amazon, eBay)	3%
From another source	2%

4.1.3 Dishwasher Type

Respondents were asked to indicate the relevant product category for their recent dishwasher purchase. The results are provided in Figure 4.1.

The majority (73 percent) of respondents reported purchasing an under-counter dishwasher, with the remainder of the responses distributed approximately evenly among the other options (built-in/custom, portable, drawer, countertop, in-sink).

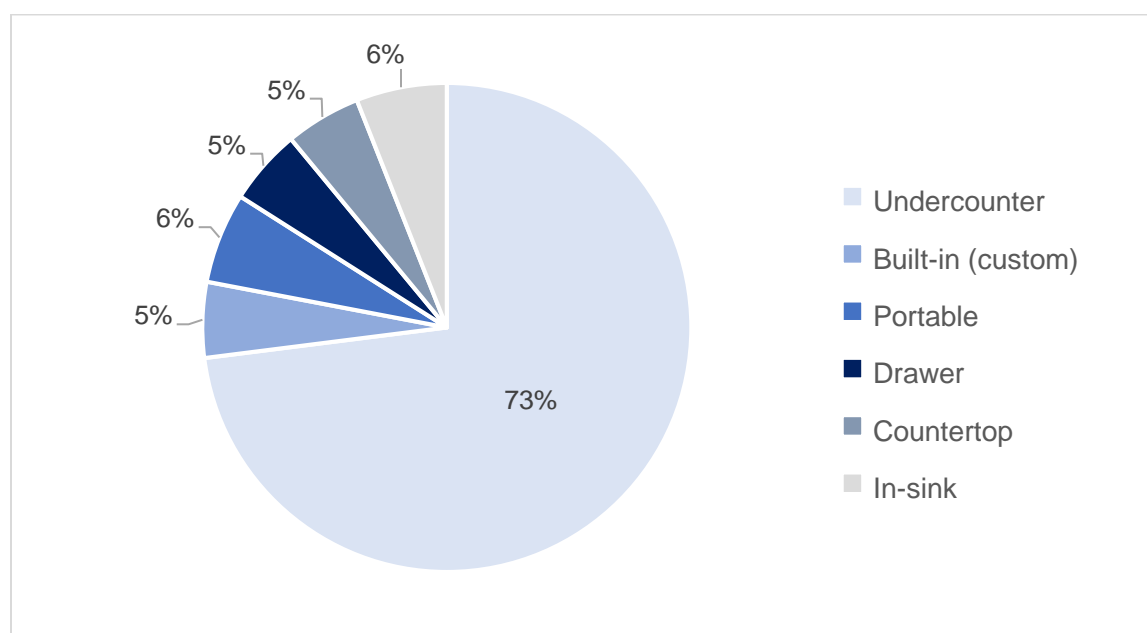


Figure 4.1 Type of dishwasher purchase (weighted), N = 1201

4.1.4 Dishwasher Width

Respondents were asked to indicate the width of their recently purchased dishwasher, which has implications for how manufacturers classify, and ultimately market, dishwasher products. Results are shown in Figure 4.2. The majority (80 percent) of respondents reported purchasing a “standard-size” dishwasher — defined as a dishwasher measuring between 18 and 24 inches in width, with space for 8 or more place settings, plus six serving pieces. Other responses were an oversized dishwasher defined as 30 inches wide (12 percent), custom and greater than 30 inches wide (3 percent), and don’t know/not sure (5 percent). Less than one percent of respondents reported purchasing a “compact” dishwasher (defined as less than 18 inches wide with space for less than 8 place settings).

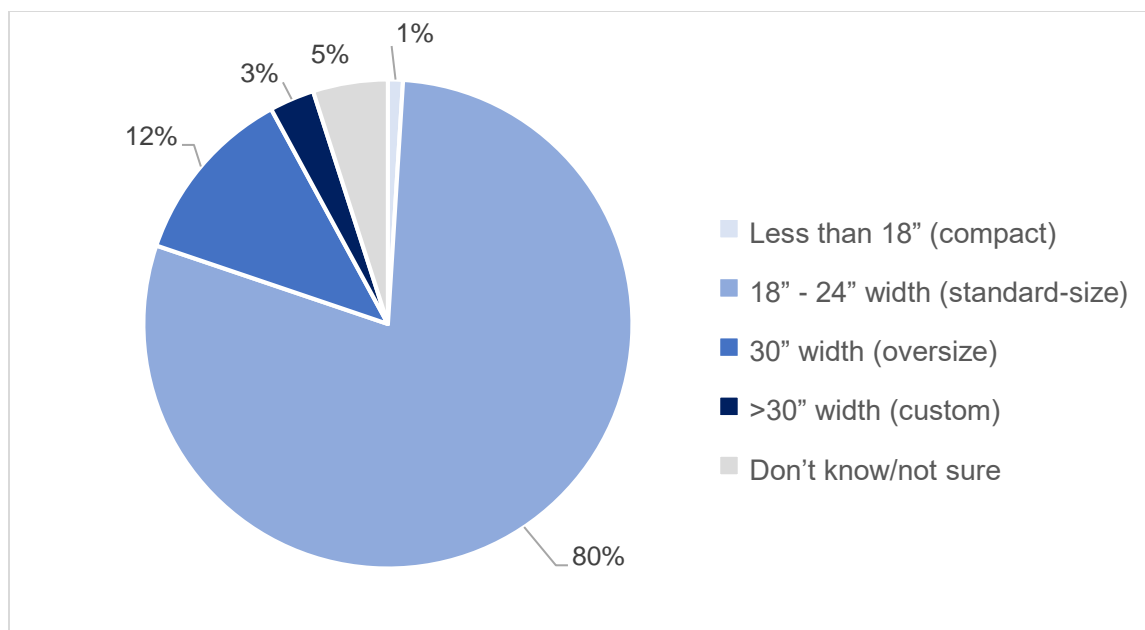


Figure 4.2. Dishwasher width (weighted), N = 1201

4.1.5 Smart Feature

Newer dishwashers can have the ability to establish a connection to household internet allowing the homeowner to operate the dishwasher via a network connection. Survey respondents were asked whether they had smart home technologies—defined in our survey as technologies that “allow you to control your home appliances and/or lighting through a wireless connection to your smartphone, tablet, smart speaker/display, or other device.”

Out of the 61 percent of respondents who indicated having at least one type of smart home technology, 23 percent reported having a smart dishwasher operable through wireless connection. See Table 4.4.

Table 4.4. Smart dishwashers (weighted)

Respondent has a Dishwasher's Smart Functionality	All Respondents N=737
Yes	23%
No	73%
Don't know/not sure	4%

*Base: For respondents who have smart home technology in their primary home

Respondents who reported having a smart feature on their dishwasher also were more likely to be in one of the younger age range categories. For example, 37 percent of 18 to 24 years old, and 48 percent of 25 to 34 years old reported having a smart feature, compared with only 10 percent of 55 to 64 years old, and 3 percent of those 65 and older.

4.1.6 ENERGY STAR® and EnergyGuide Label

ENERGY STAR® is an Environmental Protection Agency (EPA) program designed to assist consumers with the selection of energy- and water-efficient products by affixing a blue and white ENERGY STAR® label to indicate at least 20 percent less energy and water use than the federal standard. No energy or

water use information is listed on the ENERGY STAR® label itself, and a portion of the market is able to meet EPA qualifications earning the ability to display the ENERGY STAR® label.

The survey found that almost 80 percent of respondents had purchased an ENERGY STAR® dishwasher (see Table 4.5). This is in line with data found in the US DOE’s Compliance Certification database, which indicates that approximately 86 percent of dishwashers on the market are ENERGY STAR® certified.⁵ Of the 80 percent of respondents that reported purchasing an ENERGY STAR® dishwasher, the majority wanted the energy savings offered by the ENERGY STAR®-labelled model (see Table 4.6).

Table 4.5. ENERGY STAR® labeled model (weighted)

ENERGY STAR® Labeled Model		N = 1,201
Yes		79%
No		8%
Don’t know/not sure		13%

*Base: All respondents in the complete sample

Table 4.6. Reasons for purchase of ENERGY STAR®-labeled model (weighted)

Factors for Purchase of ENERGY STAR® Qualified Model		N=612
I wanted the operating cost savings associated with the reduced energy consumption of ENERGY STAR® models compared non-ENERGY STAR® models		73%
I wanted the environmental benefits associated with reduced energy consumption of ENERGY STAR® compared to non-ENERGY STAR® models		51%
The ENERGY STAR® model I purchased has the performance features I was looking for		48%

*Base: Respondents who saw the ENERGY STAR® label and took it into account in their purchase decision. Respondents were allowed to choose more than one option leading to column totals potentially summing to more than 100%.

The EnergyGuide label is a Federal Trade Commission program that uses a yellow label to report a product’s estimated annual energy use and operating costs according to the federal test procedure to facilitate comparisons between similar models. Dishwashers are among those appliances that are legally required to carry an EnergyGuide label as stated in the Energy Labeling Rule. DOE’s test procedures for the basis for the values included on the label.^r

Approximately two-thirds of respondents were aware of the EnergyGuide label but the label was not the primary determining factor for which dishwasher they chose (see Table 4.7).

^r <https://www.ftc.gov/tips-advice/business-center/guidance/energyguide-labeling-faqs-appliance-manufacturers>

Table 4.7. Influence of EnergyGuide label in decision-making process (weighted)

Influence of EnergyGuide Label on Decision Making		N=691
I used EnergyGuide labels, but other factors were more important in my final decision		64%
I used EnergyGuide labels to find a model with lower energy consumption than other available options		36%
Other		1%

*Base: For respondents who looked at EnergyGuide labels and compared energy consumption of different choices/options

4.2 Dishwasher Repair

The survey also collected information on consumer repair decisions. Dishwasher repair costs are important in understanding whether users choose to repair or replace their dishwasher, which can impact trends toward higher efficiency products as consumers may opt to replace, rather than repair, older units with newer, typically more efficient units.

Respondents were asked whether their dishwasher had ever needed a repair, and if so, how the repair was conducted (see Table 4.8). The majority (78 percent) of respondents indicated that their dishwasher had never needed repair.

Table 4.8. Dishwasher repair experience (weighted)

Dishwasher Repair		N=1,201
No, I have never had to repair a dishwasher		78%
Yes, it was covered through the warranty		8%
Yes, we were able to repair on our own		6%
Yes, we had to hire someone for the repair		6%
Yes, the manufacturer support had to fix the repair		2%

Respondents who had their dishwasher (either current or previously owns) repaired at some point in the past were also asked to provide the age of their dishwasher at the time of repair. Results are shown in Figure . Over half of dishwashers (62 percent) required repair within four years of purchase. Twenty-seven percent were 5-7 years old at the time of repair, and 10 percent were at least 8 years old.

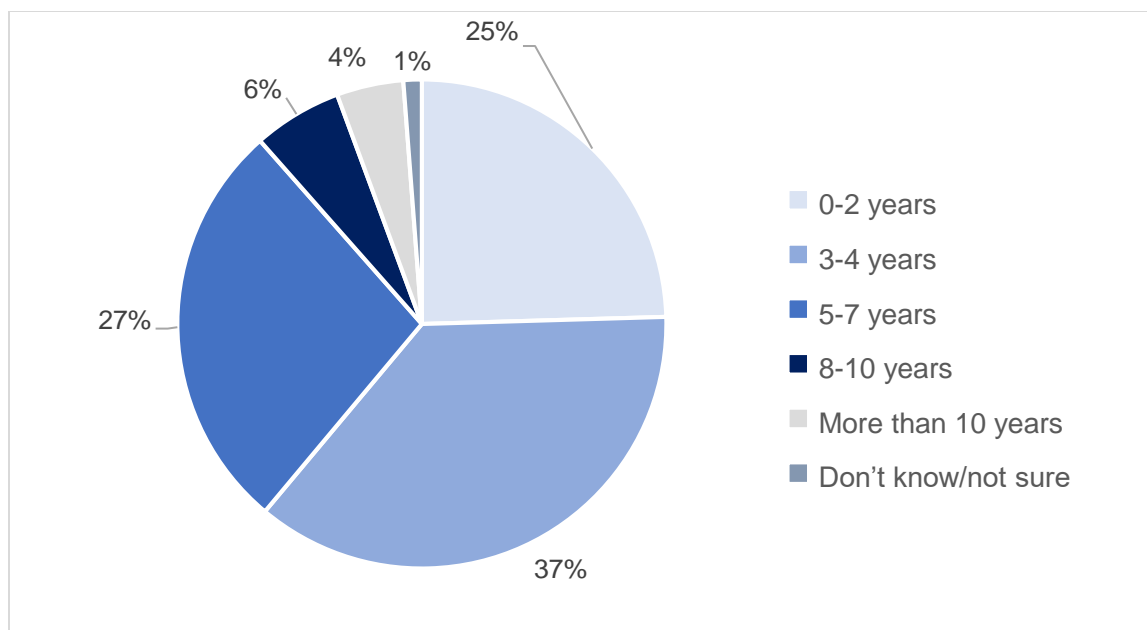


Figure 4.3. Age of dishwasher at time of repair (weighted), N = 223

Respondents also indicated how much the dishwasher repair cost. Results are shown in Figure 4.4. Approximately one quarter (24 percent) of repairs cost less than \$50, and 20 percent cost between \$50 and \$100. The most common response (45 percent) was a repair cost of between \$101 and \$200.

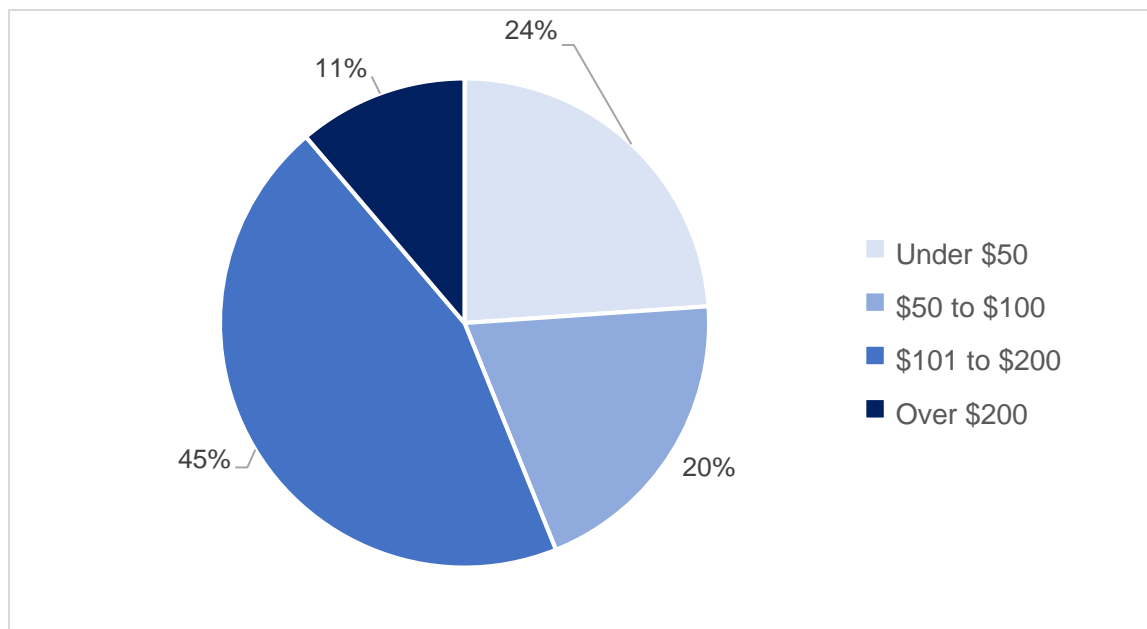


Figure 4.4. Dishwasher repair cost (weighted), N = 192^s

^s 31 respondents indicated “don’t know/not sure” when asked how much their dishwasher repair cost.

4.3 Dishwasher Usage

Dishwasher usage frequency contributes to determination of overall annual energy and water use. This section explores dishwasher usage results generally, as well as for key demographics and by consumer behavior. Tables with sample sizes for each respondent subcategory are included when results are presented for subgroups.

The survey asked respondents to report their weekly dishwasher use. Respondents chose from five frequency ranges: more than once per day, once per day, 4-6 times per week, 1-3 times per week, and less than once per week. As shown in Figure 4.5, nearly half (46 percent) of respondents indicated that they run their dishwasher between 1 and 3 times per week, and only 4 percent run their dishwasher more their dishwasher more than once a day.

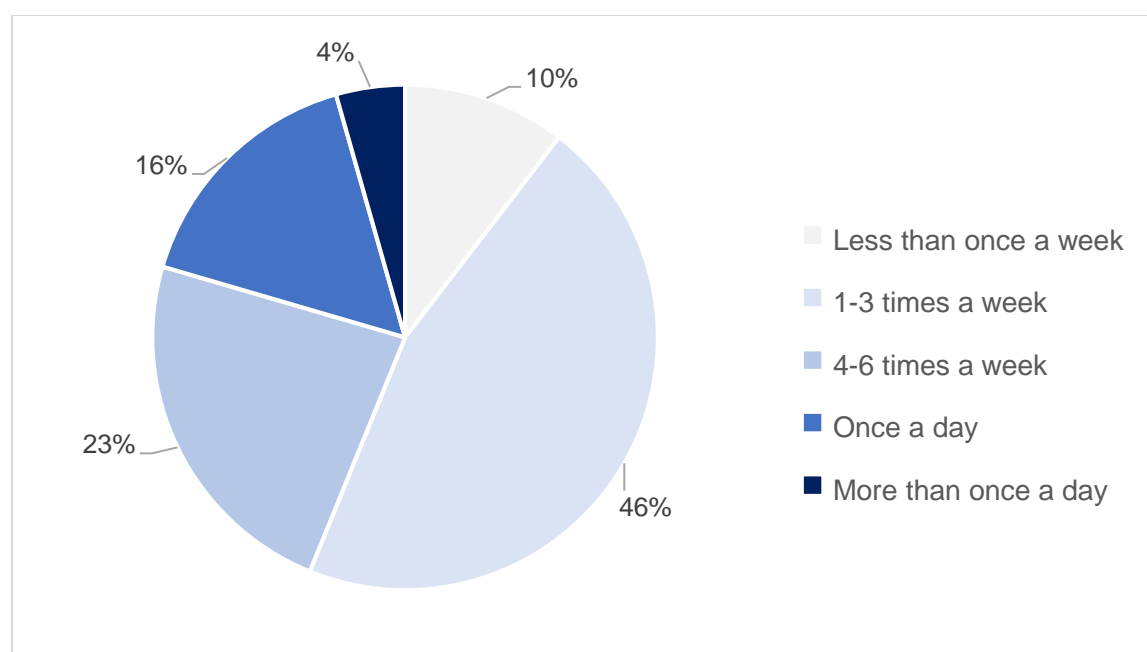


Figure 4.5. Dishwasher usage (weighted), N = 1,201

4.3.1 Dishwasher Usage and Key Demographics

We further explored these results by analyzing dishwasher use frequency across several key demographics: age, income, employment status, and household occupancy.

4.3.1.1 Dishwasher Usage by Respondent Age

Respondents reported their age by identifying with one of six age bins. Dishwasher usage frequency for each respondent age bin is shown in Figure 4.6. Respondents aged 18 to 34 are more likely than any other age group to report one of the three highest usage categories (more than once a day, once a day, and 4 to 6 times a day). Conversely, participants in older age categories were less likely to report these higher usage categories. For example, 57 percent of respondents ages 18 to 34 indicated that one of the three highest usage categories best represented their dishwasher usage, as compared to only 32 percent of respondents ages 65 and older.

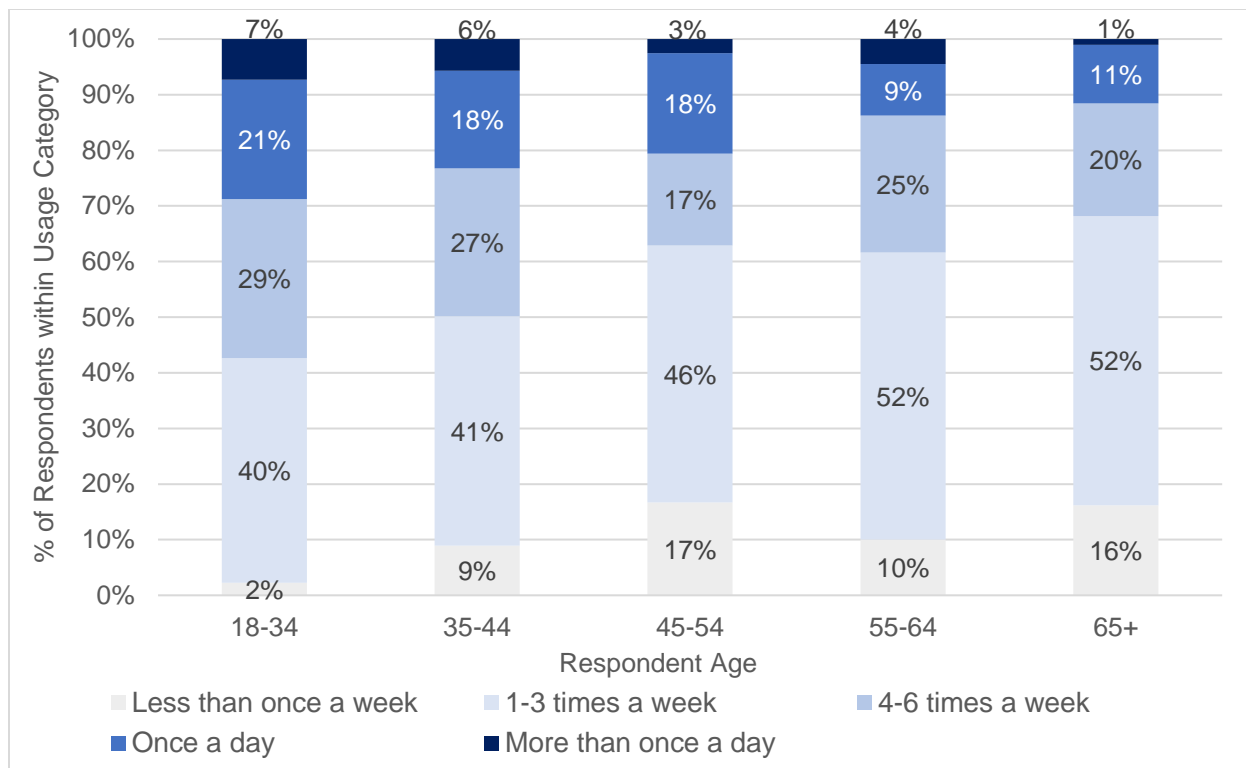


Figure 4.6. Dishwasher usage by respondent age (weighted), $N = 1,201$

Table 4.9 Sample size by respondent age (weighted)

18-34 [†]	35-44	45-54	55-64	65+	Total (N)
Sum of sample weights					
299	217	283	212	190	1,201
Sample counts					
98	191	265	305	342	1,201

Considering lower dishwasher use among senior respondents, we examined the usage distribution for senior-only households (see Table 3.2). Results are presented in Figure 4.7. When comparing to Figure 4.5**Figure** (which shows the entire survey population), we observe that senior-only households are more likely to select one of the lower weekly usage categories.

[†] The two youngest age groups (18-24 and 25-34) were combined to obtain a larger sample size.

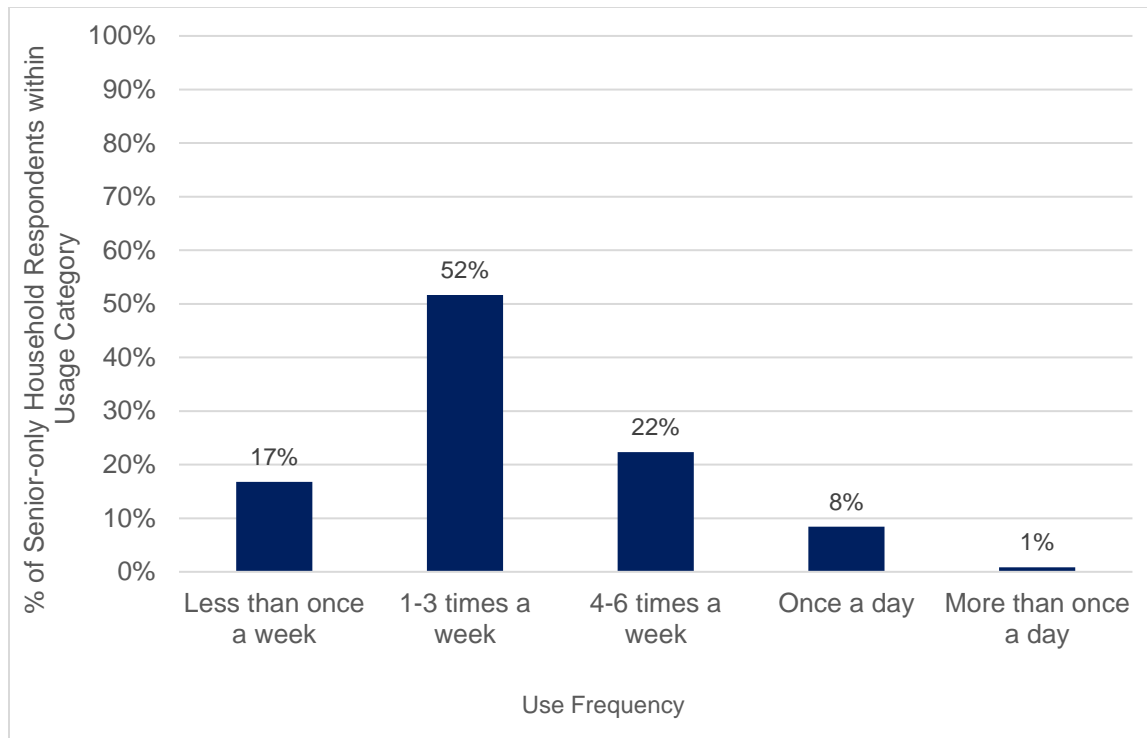


Figure 4.7. Dishwasher usage for senior-only households (weighted), $N = 272$

4.3.1.2 Dishwasher Usage by Income

Respondents were required to report household income in the demographics section of survey by selecting one of nine income bins. Results are shown in Figure 4.8. While one might expect higher-income households to run their dishwasher more often due to lower price sensitivity to utility costs (water and energy bills), there also are other factors such as dining out of the home more often that could reduce dishwasher use. Certain income groups (particularly those that make less than \$35,000 annually) have small sample sizes; therefore, results were combined for the three lowest income groups results and may not be conclusive. Households earning less than \$75,000 annually appear most likely to report running their dishwasher less than once per week (the lowest usage option), while households earning \$150,000 or more annually appear to be most likely to run their dishwasher at least once a day. There are no consistent trends across the other income bins.

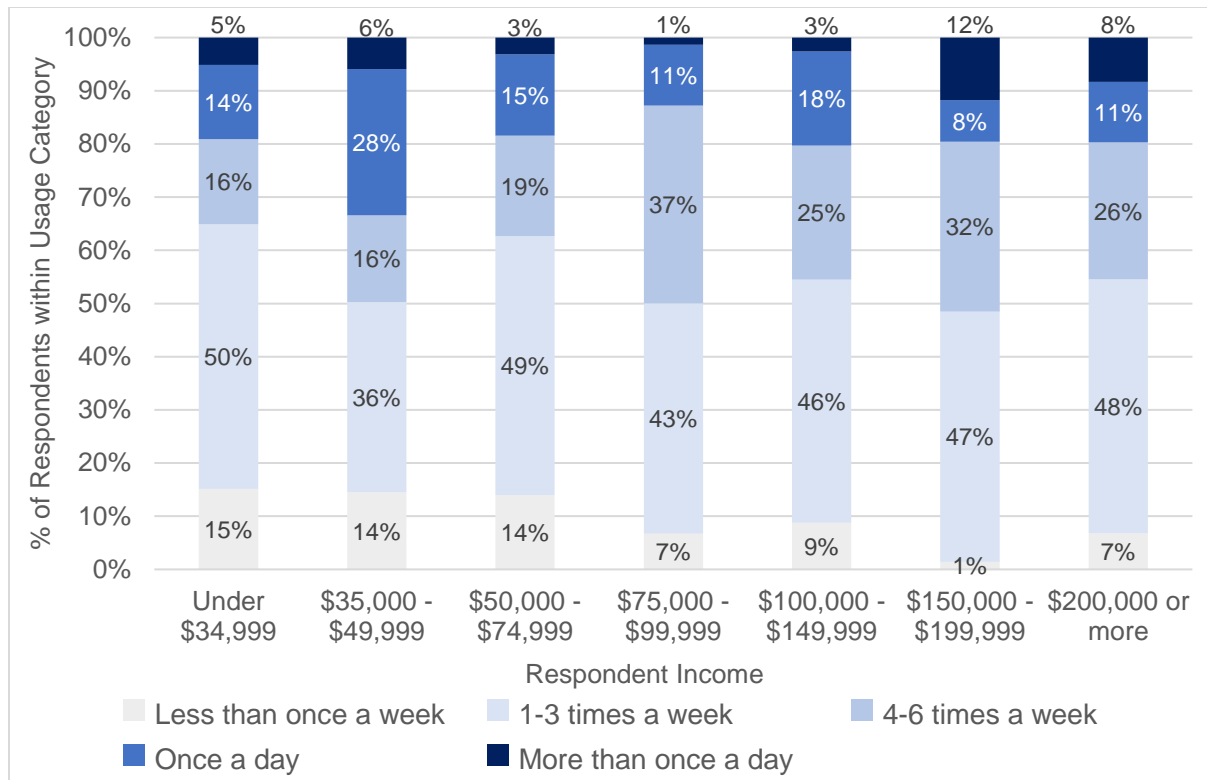


Figure 4.8. Dishwasher usage by income (weighted), N = 1,201

Table 4.10. Sample size by income

Annual Household Income								
Under \$34,999	\$35,000 - \$49,999	\$50,000 - \$74,999	\$75,000 - \$99,999	\$100,000 - \$149,999	\$150,000 - \$199,999	\$200,000+	Prefer not to answer	Total (N)
Sum of sample weights								
186	147	222	181	244	99	87	35	1,201
Sample counts								
73	95	216	239	307	126	105	40	1,201

4.3.1.3 Dishwasher Usage by Employment Status

Employment status and lifestyle can have implications for dishwasher usage. We assumed that consumers that are employed and work outside of the home would spend less time at home, and therefore ultimately prepare fewer meals at home. For this reason, we explored dishwasher usage across employment status groups. Respondents reported their employment status, choosing from the following categories: employed full time, employed part time, stay at home worker without salary, student, retired, business owner, other, and prefer not to answer. It is likely that respondents in the “stay at home worker with no salary” and “retired” categories are at home more than respondents in the other categories. However, these response options are an imperfect measure of how often a respondent may be at home, considering employed workers could work from home, for example. Additionally, there are other interactions with some of these demographics. For example, a retired individual is likely to be older, and less likely to have children living in the home, both of which can reduce dishwasher usage despite the fact that the likelihood of being home throughout the day (and therefore the likelihood of generating dirty dishes) is higher. Results are shown in Figure 4.9. It is important to note that sample sizes for the “student,” “business owner,” “other,” and “prefer not to answer” categories are small and results cannot be reliably interpreted.

Comparing results for respondents employed full time, employed part time, and for stay at home workers without salaries, we observe that stay at home workers were substantially more likely to report running their dishwasher in the second and third highest usage categories- once a day (39 percent) or 4-6 times per week (36 percent). Respondents employed full time were most likely to report running their dishwasher more than once per day (aside from the “Student” category, which cannot be reliably interpreted due to small sample size).

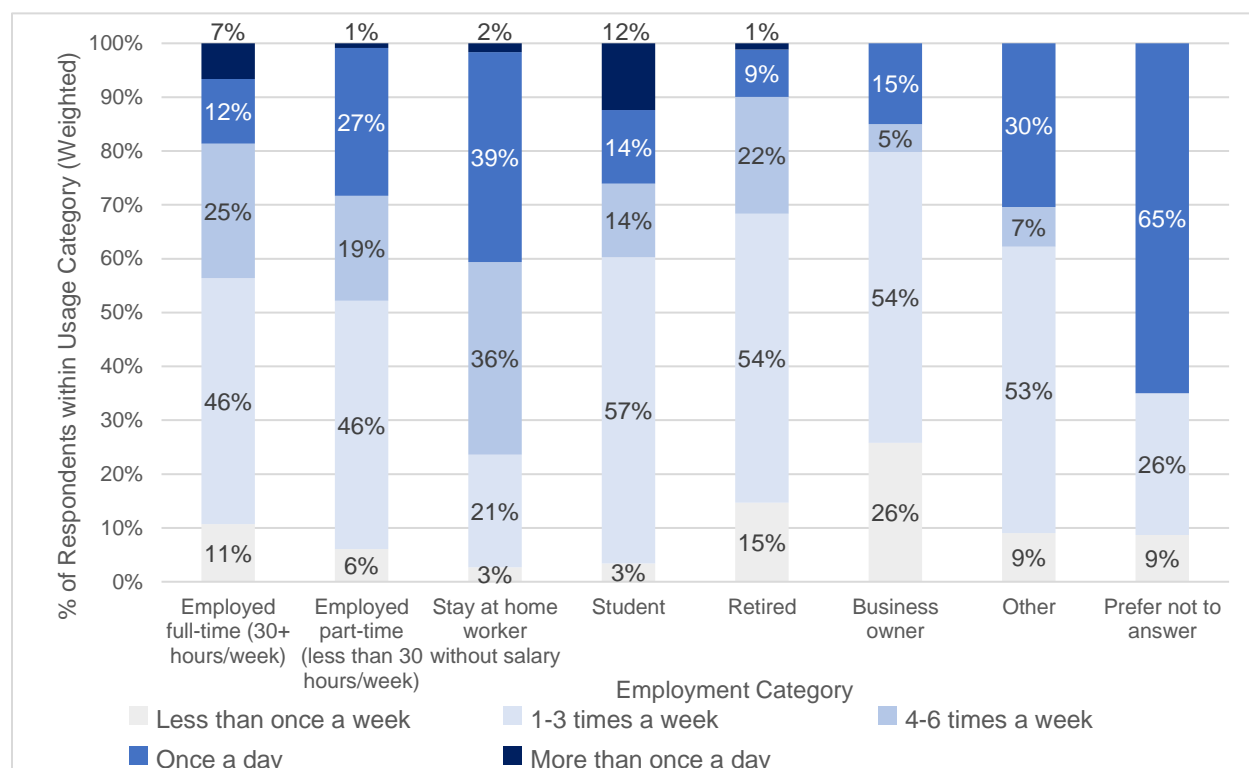


Figure 4.9 Dishwasher usage by employment status (weighted), N = 1,201

Table 4.11. Sample size by employment category

Employment Category								
Employed full-time (30+ hours/week)	Employed part-time (less than 30 hours/week)	Stay at home worker without salary	Student	Retired	Business owner	Other	Prefer not to answer	Total (N)
Sum of sample weights								
645	96	109	38	247	23	35	9	1,201
Sample counts								
574	109	81	9	369	33	19	7	1,201

4.3.1.4 Dishwasher Usage by Occupancy Characteristics

The survey asked respondents to report the number of household members for each of the following age categories as shown in Figure 4.6. We posited that as the number of household occupants in a home increases, so dishwasher usage would also increase. This is a reasonable conclusion when considering that

each additional occupant would likely increase the number of place settings used. As shown in Figure 4.10, households with a larger number of occupants did generally report using their dishwashers more frequently overall. While only 31 percent of single person households reported usage in the highest three usage categories (“more than once a day,” “once a day,” and “4-6 times per week,”) that percentage increased to 35 percent for 2 person households, 47 percent for three person households, 61 percent for 4 person households, 63 percent for 5 person households, and 84 percent for 6+ person households.^u However, given the small sample sizes for the two largest household categories (5 person and 6+ person households), these results should be interpreted with caution.

This pattern, however, is largely driven by the second and third highest use categories – which both show a clear pattern of an increase in usage for larger households. The highest usage category “More than once a day,” does not present a clear pattern. Unexpectedly a larger fraction of households with only one occupant reported use of “More than once a day” (the highest-frequency category) compared to all other household sizes. While only 17 and 11 percent of respondents in households with one or two occupants respectively reported running their dishwasher “less than once per week,” this is a higher frequency than larger households reported.

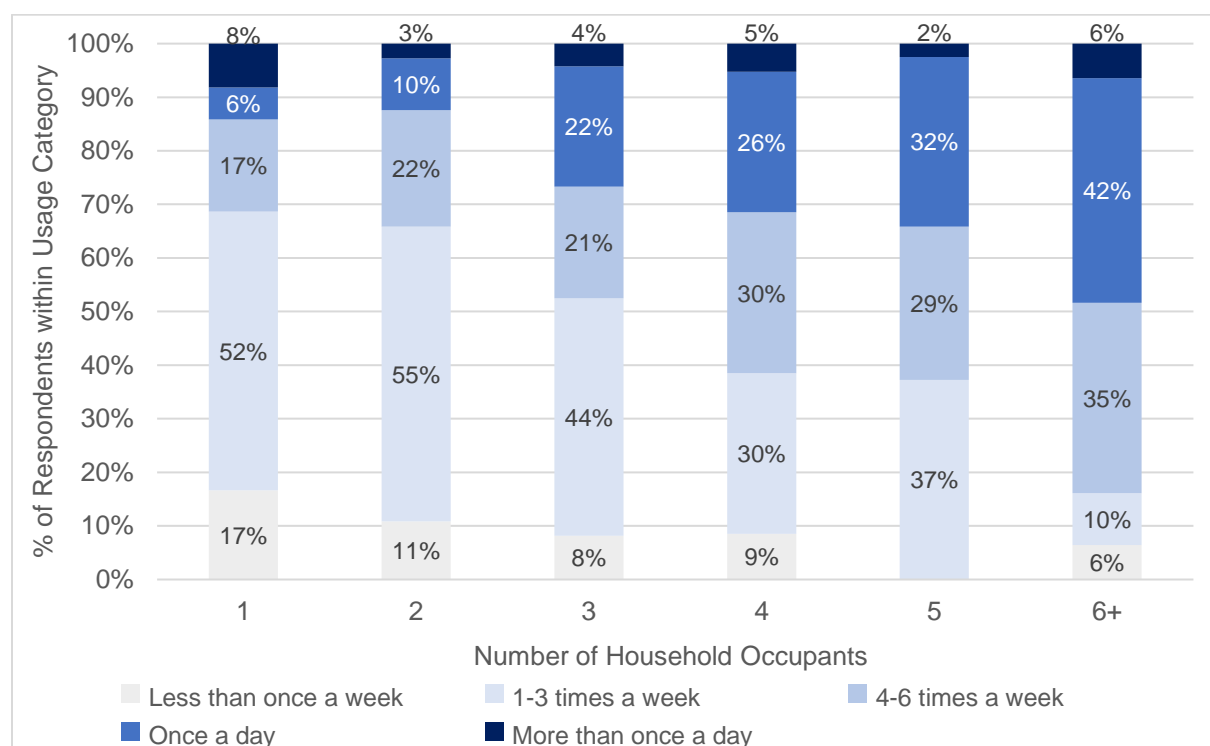


Figure 4.10. Weekly dishwasher usage by number of household occupants (weighted), N = 1,183

^u Note that percentages may not add up directly from Figure 4.8 given rounding.

Table 4.12 Sample size by number of household occupants

Number of occupants						
1	2	3	4	5	6+	Total (N) ^v
Sum of sample weights						
240	396	253	189	43	50	1,172
Sum of counts						
168	560	222	166	36	31	1,183

4.3.2 Dishwasher Usage and Consumer Behavior

The survey asked questions related to respondent behavior and attitudes towards dishwasher usage and energy efficiency overall. Select parameters are explored below that potentially have implications for dishwasher usage frequency. Additionally, usage is examined for ENERGY STAR® and non-ENERGY STAR® certified units.

4.3.2.1 Dishwasher Pre-Rinsing and Re-Runs

Respondents provided information on a number of habits related to their dishwasher usage—specifically, whether they pre-clean dishes before loading them into the dishwasher and whether (and how frequently) they needed to re-run their dishwasher due to unsatisfactory cleaning. Results are provided in Figure 4.11.

Over half (55 percent) of respondents indicated that they typically pre-rinse dishes using the kitchen sink before loading dishes into their dishwasher, while a third (33 percent) reported scraping food off, but not pre-rinsing before loading. Only 12 percent of respondents reported that they did not pre-rinse dishes.

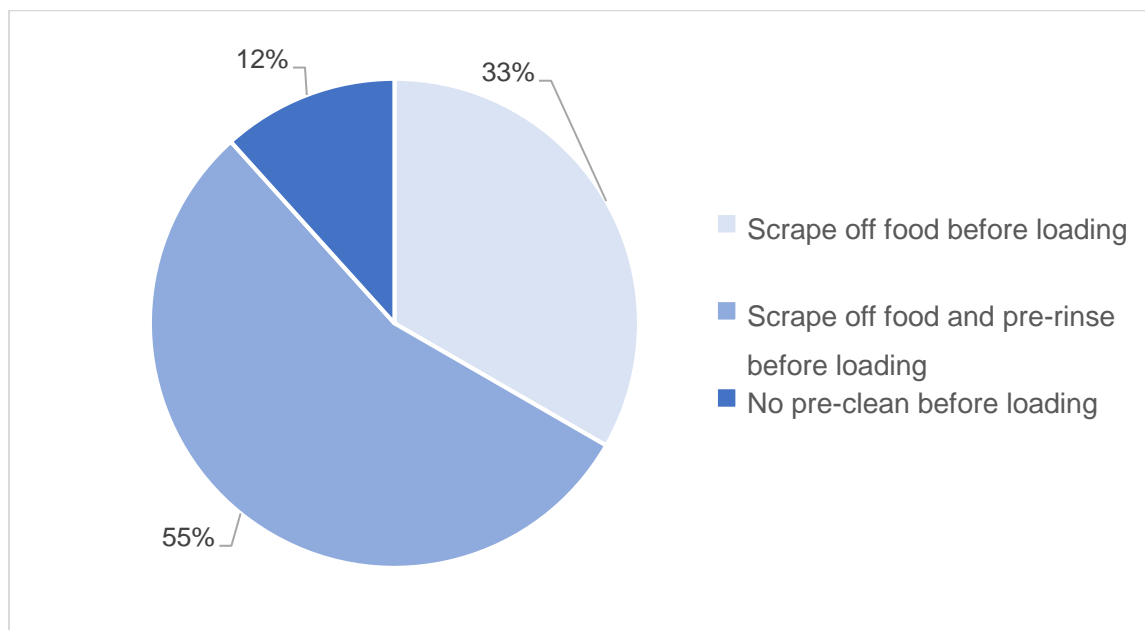


Figure 4.11. Pre-treatment of dishes before loading into dishwasher (weighted), N = 1,201

^v Sum of sample weights and sample counts differ due to some records that reported an illogical response and may have misunderstood the question (reported “zero” household members in every age category, counting themselves).

Respondents were also asked whether they had to re-run their dishwasher due to inadequate cleaning, and if so, how frequently. Results are presented in Figure 4.12. The majority (57 percent) of respondents reported that they did not re-run their dishwasher. About a quarter (26 percent) re-run their dishwasher, but rarely. The remaining respondents (17 percent) indicated that they “sometimes” re-run their dishwasher.

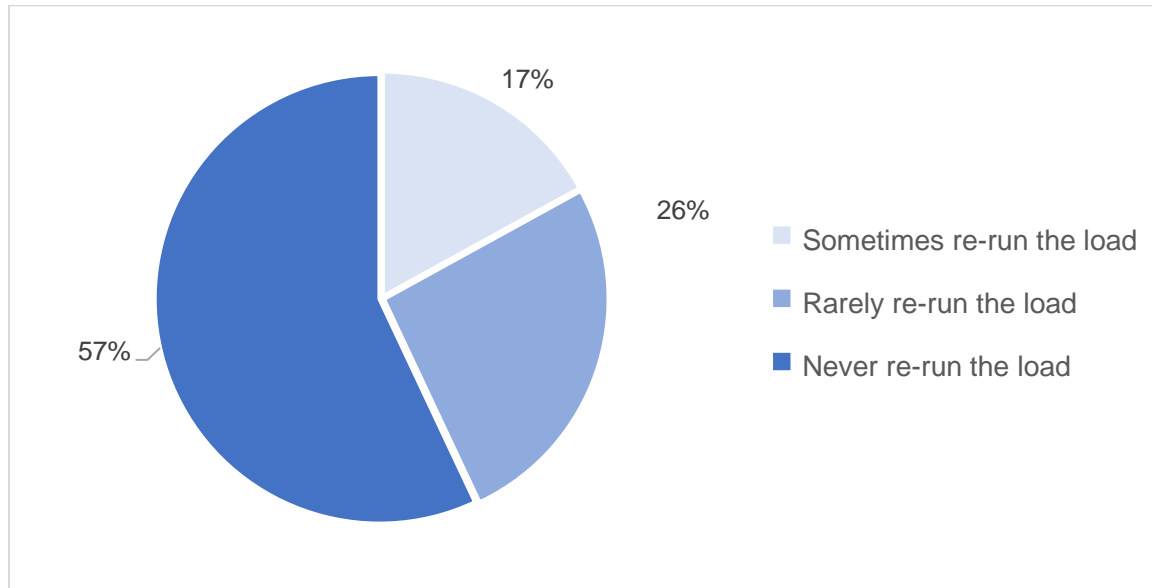


Figure 4.12. Dishwasher re-runs and frequency (weighted), $N = 1,201$

Respondents that reported they “sometimes” re-run their dishwasher (as shown in Figure 4.13) were asked to indicate how often they do so. Results are shown in Figure 4.13. Over half (56 percent) of respondents reported that they re-run their dishwasher between 1 and 3 times per week.

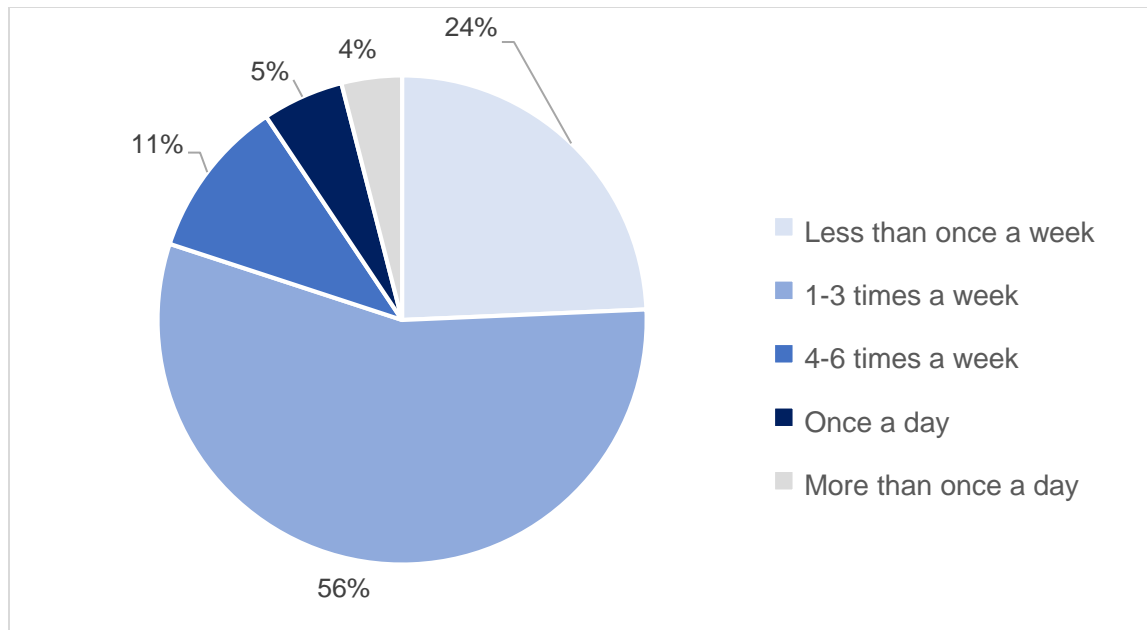


Figure 4.13. Frequency of cycle re-runs (weighted), N = 110

4.3.2.2 Dishwasher Usage by Smart Feature Usage

Survey respondents were asked to select all the ways in which they use the smart functionality of their dishwasher (if applicable). Of the respondents who have and use their smart feature, the most common action was to lock and unlock the dishwasher door (61 percent). Other responses were to start and stop cycles (59 percent), to manage settings (49 percent), to receive updates on cycle completion (48 percent), to receive updates on the level of detergent in dishwasher (29 percent), and to monitor energy usage and consumption (20 percent).

Several of these smart feature usage habits were thought to potentially impact overall dishwasher usage. For instance, the smart feature to start and stop cycles dictates when to begin a dishwasher cycle and could potentially influence how frequently the dishwasher was run. Note that because only a small number of respondents (74 total) indicated they used their dishwasher Smart Feature, the sample size is small compared to the larger survey sample. Results in Figure 4.14 show weekly dishwasher usage for respondents who do use their dishwasher to start and stop cycles as compared to those who do not (but do use the smart feature for at least one other function). While we observe more frequent dishwasher usage for respondents who use their dishwasher's smart feature to start and stop cycles, there are a number of confounding variables (e.g. household occupancy, income, etc.) that preclude any definitive conclusions.

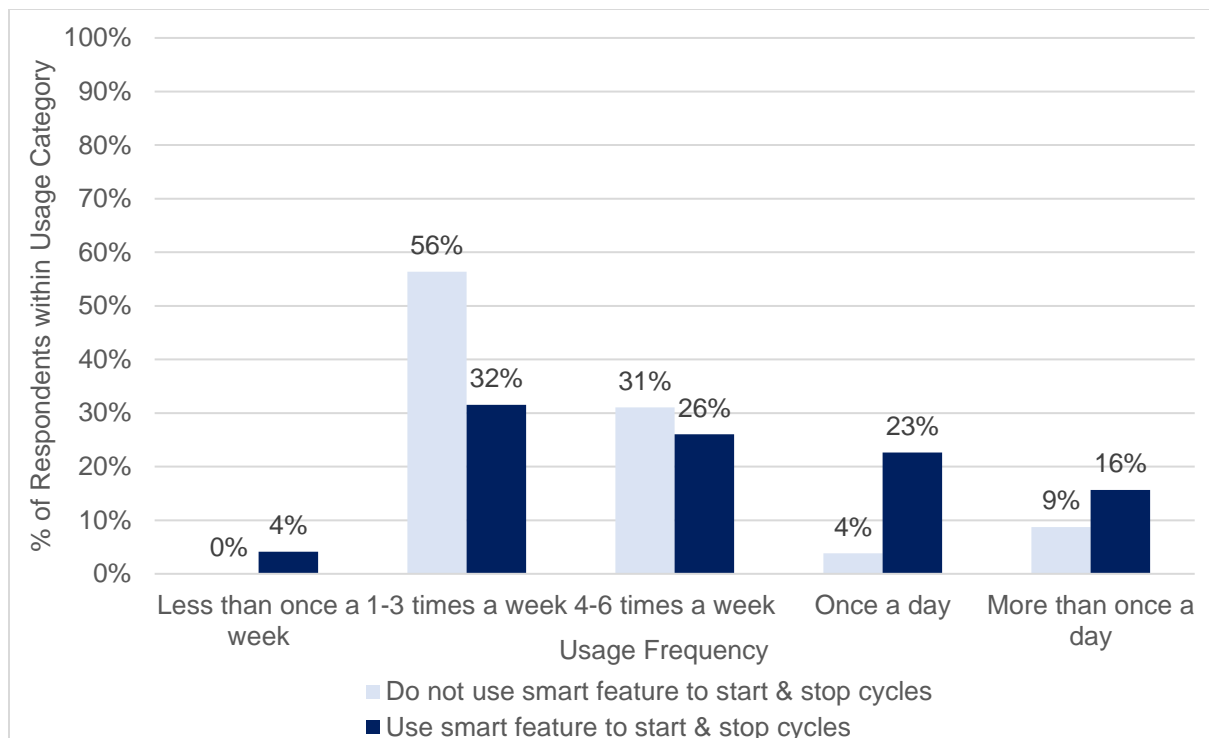


Figure 4.14. Usage for Respondents based on whether they use the smart feature to start and stop cycles (weighted), N = 74

4.3.2.3 Dishwasher Usage and ENERGY STAR®

We examined whether consumers who purchased an ENERGY STAR® dishwasher used their dishwasher more or less frequently (see Figure 4.15). Results are largely mixed and do not reveal a clear pattern of differences in usage.

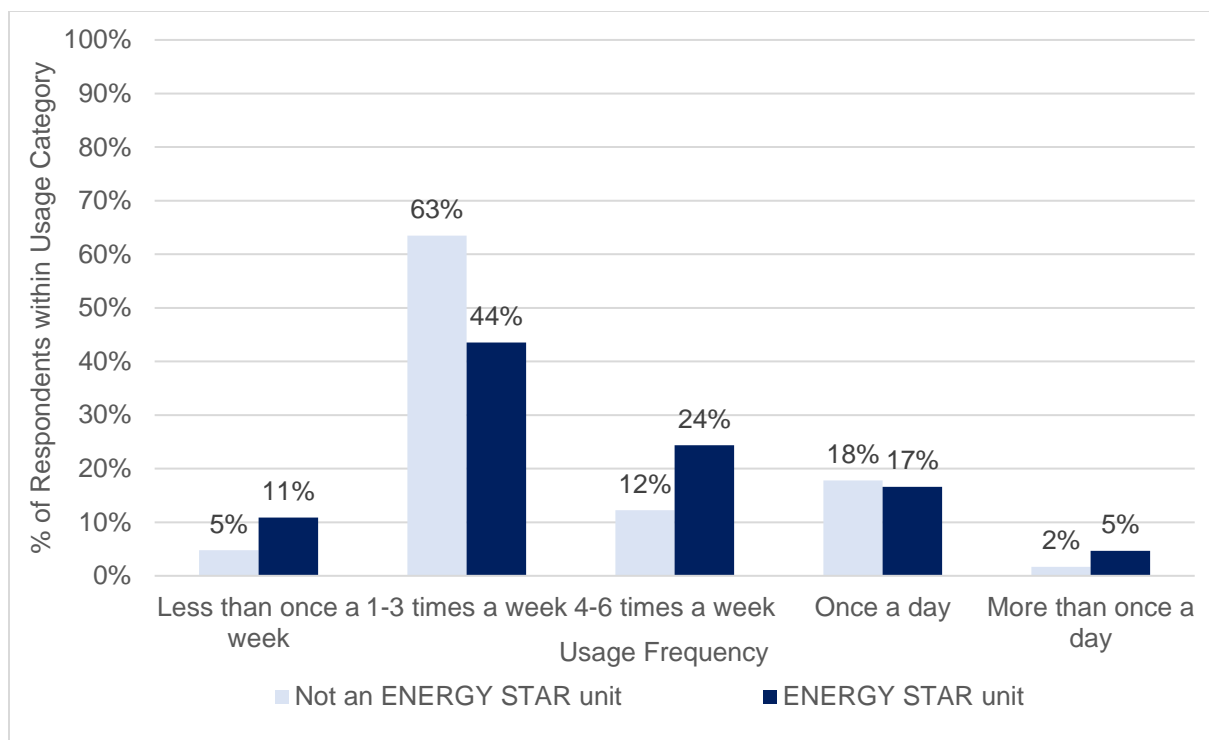


Figure 4.15 Usage frequency for ENERGY STAR® and non-ENERGY STAR® certified units (weighted), N = 998

Respondents were also asked to choose from a list of reasons that helped drive their decision to purchase an ENERGY STAR® dishwasher. One of the available reasons was the operating costs savings associated with the reduced consumption of an ENERGY STAR® model. Consumers who are aware of the operating costs (and savings opportunities) may be more likely to run their dishwasher less frequently in an effort to reduce energy and water operating costs. However, it is also possible that those consumers tend to run their dishwashers more frequently and, therefore, are more interested in savings. Results are presented in Figure 4.16. We find that respondents motivated by operating cost savings when deciding to purchase an ENERGY STAR® model are somewhat more likely to use their dishwasher at least once per day than respondents who are not concerned about cost savings.

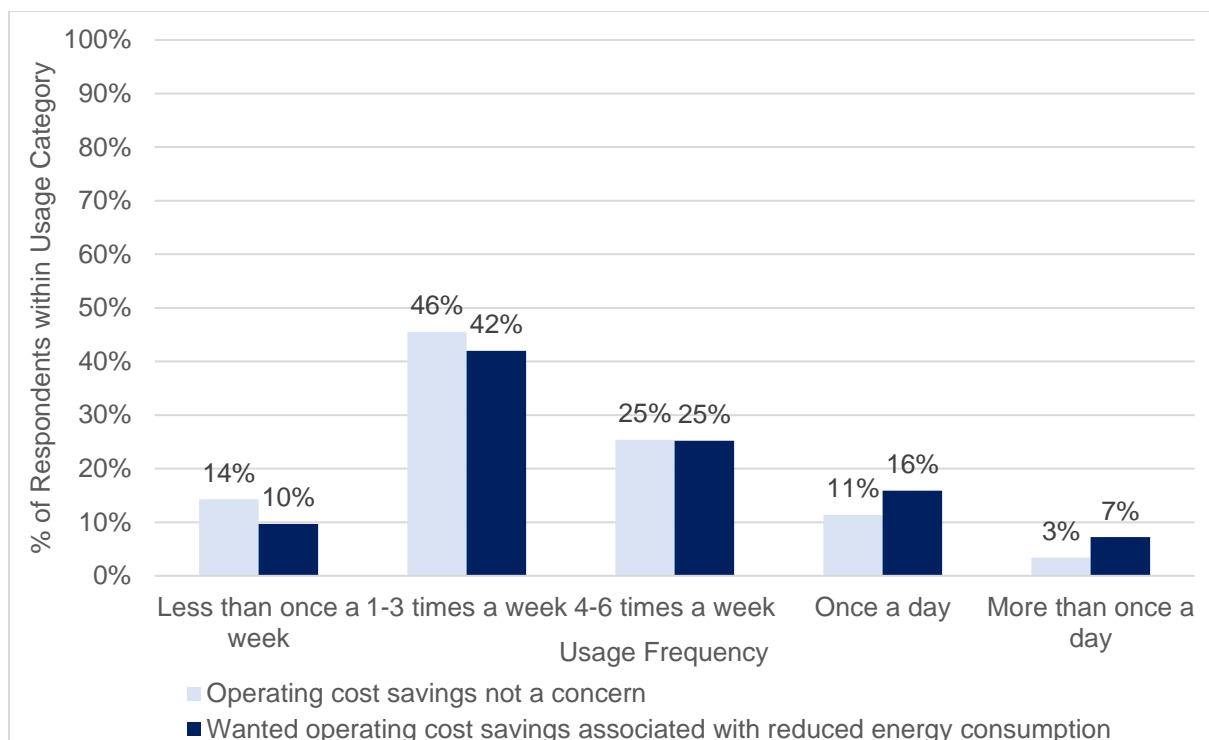


Figure 4.16. Usage for consumers who took operating cost savings into account in purchase decision, (weighted), N = 655

5. CONCLUSION & FUTURE RESEARCH

This survey effort sought information that would increase understanding of the factors that influence consumer dishwasher purchase decisions. We collected data on dishwasher product features and consumer characteristics that have implications for dishwasher usage, and ultimately energy and water consumption. Collecting household demographic data along with dishwasher attribute preferences enabled us to observe attribute ranking by household income, occupant employment status, household size, and occupant age. Our findings provide a more nuanced understanding of how dishwasher use varies among different demographic groups. (See Section 2 for an overview of the survey and Appendix A for the survey instrument).

The survey employed a unique prioritization method that allowed survey respondents to rank dishwasher attributes in order of importance which then play a role in dishwasher purchasing decisions. Of the 18 dishwasher attributes identified, the data showed that price ranked as the most important factor for consumers in their dishwasher purchase, followed by sound level when dishwashers were in use, dishwasher style, and dishwasher brand. Energy considerations were relevant for many consumers, with energy efficiency ranked as the fifth most important, and energy bill cost savings ranked as the sixth most important factor. (See Section 3 for an accounting of the ASEMAP approach and Appendix B for a full description of the ASEMAP results).

Some key findings from the survey data show that:

- the purchase price preferred by the vast majority of consumers was \$500. The lowest income group selected \$250 as their most preferred price point, and the highest income group selected \$500 and \$750 as their most preferred price point.
- the preference for energy efficiency increased as both household income decreased and household size increased;
- the majority of respondents indicated that they ran their dishwasher between 1 to 3 times per week, slightly less than found in RECS 2015 usage frequency. Dishwasher usage generally declined as respondent age increased, with senior-only households reporting notably less dishwasher usage than the national average. Conversely, households reported running their dishwasher more frequently as household occupancy increased. (See Section 4 for details on the survey results and Appendix C for general survey results.)

This survey captured valuable data that enables a more accurate depiction of dishwasher purchases, preferences, and use among US households. Regularly conducting this type of survey could offer insights to changes in consumer preferences and the primary factors that cause these changes. Future research could assist utility companies to determine the electricity usage peak hours by including consumer behavior questions regarding time of the day, day of the week and other seasonal and regional impacts of dishwasher operation. Assessing consumers' sensitivity towards different price points could also inform estimation of future sales and market share projections. Moreover, understanding the variation and the factors that impact the energy and water consumption per dishwasher cycle would reduce the uncertainty associated with estimating energy savings as a result of policies that promote higher efficiency dishwashers. .

Additionally, more granular data on dishwasher usage would yield more accurate energy consumption and cycle usage. Field metering is one method that could obtain such information with more refined scales and disaggregated timeframes, though obtaining a large and representative sample could be a challenge.

APPENDIX A. SURVEY INSTRUMENT

Screener (2 mins)

Introduction

You have been selected as a candidate to take a survey on home appliances conducted by Mohan Ganeshalingam of Lawrence Berkeley National Laboratory. First, the survey is going to ask you some screening questions about your home appliances to see if you qualify for the survey. After completing the screening survey, you will be informed of whether you qualify for the full survey. Additional information about your household demographics (e.g., household income, gender, etc.) will also be asked in this section in order to weight your responses relative to other participants to be nationally representative. This screening section should take about two minutes. Note that you will not receive payment for completing the screening survey. If you qualify and complete the full survey, you will be awarded \$12 as honoraria for your time and efforts within 2-6 weeks.

Only one response per household will be awarded \$12 for completion of this survey. Your computer's IP address will be recorded as part of your survey response to ensure you have not already responded to this survey. If you agree, click next to be taken to the screening section.

[TERMINATING SCREEN: SHOW WHEN RESPONDENT IS TERMINATED]

Thank you for taking the time to fill out the screening section of the survey. Unfortunately, you did not meet the screening criteria and are not eligible to continue to the main survey. Thank you once again for your time.

SQ00. Have you or any of your immediate family members been employed in the following sectors in the past 12 months?

(Please select all that apply)

[Randomize]

- [1] Marketing or market research department/company [Thank and Terminate]
 - [2] Electric utility [Thank and Terminate]
 - [3] Gas Utility [Thank and Terminate]
 - [4] Household appliances manufacturer [Thank and Terminate]
 - [5] E-commerce/online retail company
 - [6] Public relations [Thank and Terminate]
 - [7] Bank/banking related organization
 - [8] Travel/tourism
 - [9] None of the above [EXCLUSIVE] [CONTINUE]
-

SQ01. In the past three months, have you participated in any of the following types of market research studies?

(Please select all that apply)

- [1] Power or electricity [Thank and Terminate]
- [2] Household appliances purchase [Thank and Terminate]
- [3] Automotive services

- [4] Home cleaning services
- [5] Cellular telephone providers
- [6] Internet providers
- [7] None of the above [EXCLUSIVE] [CONTINUE]

SQ02. What is your age?

(Please select one)

- [1] Under 18 years of age [Thank and Terminate]
- [2] 18-24 years of age
- [3] 25-34 years of age
- [4] 35-44 years of age
- [5] 45-54 years of age
- [6] 55-64 years of age
- [7] 65+ years of age

[SAMPLE DISTRIBUTION: IN ACCORDANCE TO US CENSUS DATA]

SQ03a. In which state do you live currently?

_____ [DROP DOWN MENU OF 50 US STATES]

[SAMPLE DISTRIBUTION: ENSURE GEOGRAPHICAL REPRESENTATION BY REGION]

SQ03b. What is the highest level of education you have completed?

(Please select one)

- [1] Some high school
- [2] High school/GED (General Educational Development)
- [3] Some college
- [4] Associate's degree
- [5] Bachelor's degree (e.g., BA, BS, etc.)
- [6] Graduate degree (e.g., JD, MA, MS, PhD, etc.)
- [99] Prefer not to answer

SQ03c. Which of the following best describes your marital status?

(Please select one)

- [1] Single
- [2] Married / Living with partner
- [3] Widowed
- [4] Divorced / Separated
- [99] Prefer not to answer

SQ03e. Which of the following categories best describes you?

(Please select all that apply)

[Randomize except OTHERS]

- [1] American Indian / Alaska Native
 - [2] Asian
 - [3] Black or African-American
 - [4] Native Hawaiian or Other Pacific Islander
 - [5] Hispanic or Latino
 - [6] White
 - [7] Other (Please specify: _____)
 - [8] Prefer not to answer
-

SQ03f. Please specify your gender.

(Please select one)

- [1] Male
 - [2] Female
 - [3] Other (Please specify: _____)
 - [99] Prefer not to answer
-

SQ03g. Which of the following best describes your total annual household income before taxes?

(Please select one)

- [1] Less than \$15,000
 - [2] \$15,000 - \$24,999
 - [3] \$25,000 - \$34,999
 - [4] \$35,000 - \$49,999
 - [5] \$50,000 - \$74,999
 - [6] \$75,000 - \$99,999
 - [7] \$100,000 - \$149,999
 - [8] \$150,000 - \$199,999
 - [9] \$200,000 or more
 - [99] Prefer not to answer
-

SQ04a. Is your primary home:

Your primary home is the residence where you live for most of the year

(Please select one)

- [1] Owned
 - [2] Rented
 - [3] Prefer not to answer
-

SQ04b. Is your primary home:





Your primary home is the residence where you live for most of the year



(Please select one)

- [1] A mobile home
 - [2] A single-family house detached from any other house
 - [3] A single-family house attached to one or more other houses (e.g., duplex, row house, or townhome)
 - [4] An apartment or flat in a complex with 2 to 4 units
 - [5] An apartment or flat in a complex with 5 or more units
 - [6] Other (Please specify: _____) [THANK AND TERMINATE]
-

SQ05. How familiar are you with the following types of dishwasher?

(Please select one option per row)

Dishwasher types	A. Not aware/Don't know this type of dishwasher	B. Have heard of it/seen it, but have never used one	C. Have used in the past, but not currently using	D. Currently using as my primary dishwasher in my home [ONLY ALLOW ONE OPTION TO BE SELECTED IN THIS COLUMN]	E. Currently using as another, secondary dishwasher in my home
Countertop 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Portable 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
In-sink 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Drawer 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	





Dishwasher types	A. Not aware/Don't know this type of dishwasher	B. Have heard of it/seen it, but have never used one	C. Have used in the past, but not currently using	D. Currently using as my primary dishwasher in my home [ONLY ALLOW ONE OPTION TO BE SELECTED IN THIS COLUMN]	E. Currently using as another, secondary dishwasher in my home
Undercounter 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Built-in (custom) 	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (Please specify:_____)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



[THANK AND TERMINATE IF OPTIONS 1, 2, 3, 4, 5 AND 6 ≠ D or E]

SQ06. When was the last time you purchased the following dishwasher for your primary home?

(Please select one option per row)

	[INSERT ONLY THOSE BRANDS AND IMAGES WHERE SQ05=D or E]	a) Less than 6 months ago	b) 6-12 months ago,	c) 12-24 months ago,	d) 2-5 years ago,	e) 5+ years ago	f) I did not purchase this dishwasher, it came with my primary home	g) Don't know/ Not sure
[1]	Countertop	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

	[INSERT ONLY THOSE BRANDS AND IMAGES WHERE SQ05=D or E]	a) Less than 6 months ago	b) 6-12 months ago,	c) 12-24 months ago,	d) 2-5 years ago,	e) 5+ years ago	f) I did not purchase this dishwasher, it came with my primary home	g) Don't know/ Not sure
								
[2]	Portable 	O	O	O	O	O	O	O
[3]	In-sink 	O	O	O	O	O	O	O
[4]	Drawer 	O	O	O	O	O	O	O

	[INSERT ONLY THOSE BRANDS AND IMAGES WHERE SQ05=D or E]	a) Less than 6 months ago	b) 6-12 months ago,	c) 12-24 months ago,	d) 2-5 years ago,	e) 5+ years ago	f) I did not purchase this dishwasher, it came with my primary home	g) Don't know/ Not sure
[5]	Undercounter 	O	O	O	O	O	O	O
[6]	Built-in (custom) 	O	O	O	O	O	O	O
[7]	Other (Please specify:_____)	O	O	O	O	O	O	O

[Thank and terminate if all options SQ06_1 through 6 \neq a or b or c or d]

QUOTA LABELS (no quotas required, this is just for labeling for pipe-ins in main survey)

- IF SQ06_1=a or b or c or d: label “countertop dishwasher”
- IF SQ06_2=a or b or c or d: label “portable dishwasher”
- IF SQ06_3=a or b or c or d: label “in-sink dishwasher”
- IF SQ06_4=a or b or c or d: label “drawer dishwasher”
- IF SQ06_5=a or b or c or d: label “undercounter dishwasher”
- IF SQ06_6=a or b or c or d: label “built-in dishwasher”

SQ07.Did you have a role in the decision-making process for the most recent purchase of a [INSERT SQ08 QUOTA LABEL] your primary home?

(Please select one)

- [1] Yes
- [2] No

[THANK AND TERMINATE IF OPTION [2] IS SELECTED]

Survey Consent

Thank you for your responses. You have qualified to participate in a survey conducted by Mohan Ganeshalingam of Lawrence Berkeley National Laboratory (LBNL) to study how consumers make purchasing decisions of home appliances. You are being asked to participate because of your dishwasher purchase.

If you agree to participate in this survey, the following will happen. You will be asked a series of questions about what factors you considered while making your purchasing decision and how you currently use your product in your home. For example, you will be asked about how often you use your dishwasher and what factors you considered when purchasing your dishwasher. This survey will take approximately 30 minutes.

Participation in research may involve a loss of privacy. Your records will be kept as confidential as possible under the law. When the results of the research are used in reports or papers, no information will be included that would reveal your identity. All data will be combined with responses from other participants for an aggregated analysis.

There will be no direct benefit to you from taking part in this study. However, it is hoped that the information gained from the study will help researchers learn more about how consumers make purchasing decisions for dishwashers and how they use their dishwasher in their home.

After the study is completed, your data will be stored for future research in consumer purchase behavior. The same confidentiality protections described above will be used.

You will be compensated \$12 for the successful completion of this survey. Only one response per household will be awarded \$12 for completion of this survey. Your computer's IP address will be recorded temporarily as part of your survey response to ensure you have not already responded to this survey. Your IP address will be deleted 30 days after LBNL has finished surveying.

Participation in this survey is voluntary. You have the right to not take part in this study or to stop taking part at any time. You are not waiving any legal claims or rights that you are otherwise entitled to because of your participation in this research study. We recommend you print this page if you would like to save this information for future reference.

Should you have any questions related to this survey, you may contact the study Principal Investigator, Mohan Ganeshalingam (510-486-7067, mganeshalingam@lbl.gov). Any questions you have about your rights as a participant will be answered by Berkeley Lab Human Subjects Committee at 510-486-5399.

By clicking "I agree" you are acknowledging that you have read this page, all of your questions have been answered to your satisfaction, and you agree to participate in this study.

[1] I agree

[2] I disagree [THANK AND TERMINATE]

Section A: Current Behavior & Usage

First, let's think about your most recent [INSERT SQ06 QUOTA LABEL] purchase.

[pipe in image from SQ06]

Please click **Next** >> to continue.

AQ01b.

What is the size of the [INSERT SQ06 QUOTA LABEL] that you most recently purchased?

(Please select one)

- [1] Less than 18" (compact)
- [2] 18" - 24" width (standard-size)
- [3] 30" width (oversize)
- [4] >30" width (custom)
- [5] Don't know/not sure

AQ03.

Which of the following reasons triggered your most recent [INSERT SQ06 QUOTA LABEL] purchase?

(Please select one)

- [1] My old dishwasher didn't work and couldn't be fixed
- [2] My old dishwasher required repair service, but I chose to buy a new dishwasher instead
- [3] I moved to a new home
- [4] I remodeled my kitchen
- [5] My old dishwasher was still functional, but I wanted a new dishwasher
- [6] I wanted an additional dishwasher
- [7] Other (Please specify: _____)

AQ04a. How did you purchase your most recent [INSERT SQ06 QUOTA LABEL]?

(Please select one)

- [1] Purchased it through a contractor/builder
- [2] Purchased it myself

AQ04b. Did you purchase your most recent [INSERT SQ06 QUOTA LABEL] with other home appliances?

(Please select one)

- [1] Yes, I purchased it together with other home appliances as a bundle
- [2] No, I purchased only the dishwasher

AQ05a. [ASK IF AQ04a=2]

Where did you purchase your most recent [INSERT SQ06 QUOTA LABEL]?

(Please select one)

- [1] From a retail store
- [2] Online - from retail store's website
- [3] Online retailer (i.e. Amazon, eBay)
- [4] From another source (Please specify: _____)

AQ05b. [ASK IF AQ05a=1] From which store did you purchase your most recent [INSERT SQ06 QUOTA LABEL]?

[ASK IF AQ05a=2] From which online store's website did you purchase your most recent [INSERT SQ06 QUOTA LABEL]?

(Please select one)

[RANDOMIZE OPTIONS]

- [1] Best Buy
- [2] Lowes
- [3] Home Depot
- [4] Costco
- [5] Walmart
- [6] Sears
- [7] Local appliance store (non-chain)
- [8] Others (Please specify: _____)

AQ05.

What is the brand of your most recently purchased [INSERT SQ06 QUOTA LABEL]?

(Please select one)

[randomize options]

- [1] Samsung
- [2] Insignia
- [3] Whirlpool
- [4] LG
- [5] KitchenAid
- [6] Amana
- [7] Frigidaire
- [8] GE
- [9] Bosch
- [10] Other (Please specify: _____)

AQ06. [DO NOT ASK IF AQ03= 3, 6, OR 7]

Was the size of your most recently purchased dishwasher the same as your old dishwasher?

(Please select one)

- [1] Yes
- [2] No
- [3] Don't know/not sure

AQ07. [ASK IF AQ06=2]

What was the size of your previous dishwasher that you replaced with your new purchase?

(Please select one)

[randomize options]

- [1] Less than 18" (compact)
- [2] 18" - 24" width (standard-size)
- [3] 30" width (oversize)
- [4] >30" width (custom)
- [5] Don't know/not sure

AQ08. Did you come across ENERGY STAR® labels while shopping for a dishwasher?

ENERGY STAR® definition (includes image): See below the ENERGY STAR® logo for your reference. This is a logo that is attached to your dishwasher if your model is an ENERGY STAR® qualified model. We are NOT referring to the yellow Energy Guide label provided by the manufacturer.



(Please select one)

- [1] Yes, I saw the ENERGY STAR® label, but didn't know what it meant
- [2] Yes, I saw the ENERGY STAR® label, but didn't take it into account in my purchase decision
- [3] Yes, I saw the ENERGY STAR® label and took it into account in my purchase decision
- [4] No, I didn't come across any ENERGY STAR® labels
- [5] No, I've never heard of ENERGY STAR®

AQ08a.

Is your most recently purchased [INSERT SQ06 QUOTA LABEL] an ENERGY STAR® [INSERT HYPERLINK OF IMAGE AND DEFINITION] dishwasher?

(Please select one)

- [1] Yes
- [2] No
- [3] Don't know/not sure

AQ08b. [SHOW IF AQ08=3 AND AQ08a=2]

What factors led you to purchase a model that was NOT ENERGY STAR® labeled?

(Please select all that apply)

- [1] ENERGY STAR® models are more expensive
- [2] Other product features are more important to me
- [3] Other (Please specify: _____)

AQ08c. [SHOW IF AQ08=3 AND AQ08a=1]

What factors led you to purchase an ENERGY STAR® qualified model?

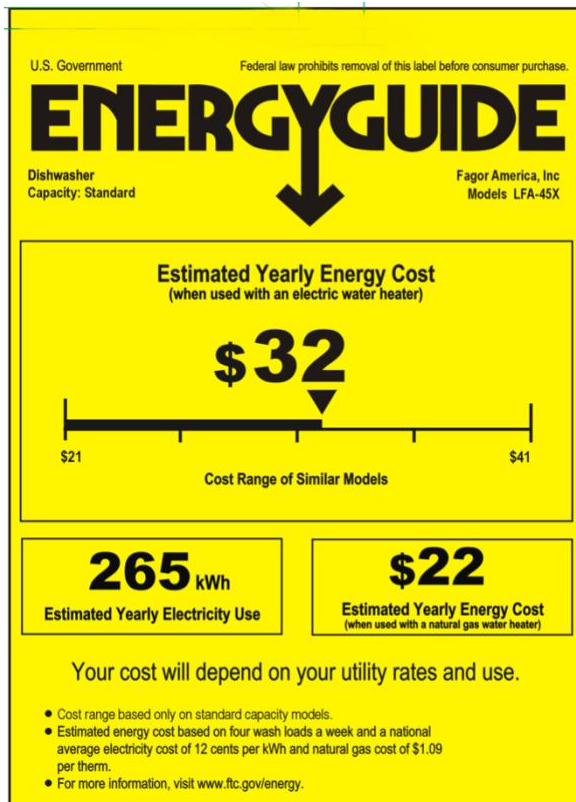
(Please select all that apply)

- [1] I wanted the environmental benefits associated with reduced energy consumption of ENERGY STAR® compared to non-ENERGY STAR® models
- [2] I wanted the operating cost savings associated with the reduced energy consumption of ENERGY STAR® models compared non-ENERGY STAR® models
- [3] The ENERGY STAR® model I purchased has the performance features I was looking for
- [4] Other (Please specify: _____)

AQ08d.

Did you come across an Energy Guide label while shopping for your dishwasher?

Energy guide definition (includes image): See below the example Energy Guide label for your reference. This label is provided by the manufacturer.



(Please select one)

- [1] Yes, I saw Energy Guide labels and didn't know what they meant
- [2] Yes, I looked at Energy Guide labels and compared energy consumption of different choices/options
- [3] I didn't pay attention to, or notice, Energy Guide labels while looking at models

AQ08e. [SHOW IF AQ08d=2]

How did Energy Guide labels influence your final purchasing decision?

(Please select one)

- [1] I used Energy Guide labels to find a model with lower energy consumption than other available options
- [2] I used Energy Guide labels, but other factors were more important in my final decision
- [3] Other (Please specify: _____)

Now, we would like to talk about your use of smart home technologies. Smart home technologies allow you to control your home appliances and/or lighting through a wireless connection to your smartphone, tablet, smart speaker/display, or other device.

Click **Next >>** to continue.

AQ09a. Do you have any of the following smart home technologies in your primary home?

(Please select all that apply)

- [1] Smart speakers/displays (e.g. Amazon Alexa, Google Home)
- [2] Smart thermostats
- [3] Smart light bulbs
- [4] Smart appliances
- [5] Smart plugs/power strips
- [6] Other (Please specify: _____)
- [7] I do not have any smart home technologies in my home [exclusive]

SKIP AQ09,10 AND 11 QUESTIONS IF AQ09a=7

AQ09.

Does your most recently purchased [INSERT SQ06 QUOTA LABEL] have smart functionality that uses wireless connection?

(Smart functionality means that you can change the settings of the dishwasher through a wireless connection with your smartphone or other devices, or Smart Home Technologies.)

(Please select one)

- [1] Yes
- [2] No
- [3] Don't know/not sure

AQ10. [ASK IF AQ09=1]

Do you currently use the smart functionality that your recently purchased [INSERT SQ06 QUOTA LABEL] has?

(Please select one)

- [8] Yes, I use my dishwasher's smart functionality to connect only to my smartphone or tablet
- [9] Yes, I use my dishwasher's smart functionality to connect only to my smart speaker or displays (e.g. Amazon Alexa, Google Home)
- [10] Yes, I use my dishwasher's smart functionality to connect to both my smartphone and smart home technologies in my home
- [11] No, I do not use the smart functionality of my dishwasher

AQ11. [ASK IF AQ10=1, 2 or 3]

How do you use your [INSERT SQ06 QUOTA LABEL]'s smart functions?

(Please select all that apply)

- [1] I use it to start and stop cycles
- [2] I use it to manage the settings of the dishwasher (i.e. cycle setting, drying setting)
- [3] I use it to lock and unlock the dishwasher door
- [4] I use it to get updates on when the cycle is complete
- [5] I use it to get updates on when my dishwasher is low on detergent or rinse aid
- [6] I use it to monitor energy use and delay cycle time to off-peak hours to save energy consumption
- [7] Others (Please specify: _____)

Now, we would like to talk about your general usage of your current [INSERT SQ06 QUOTA LABEL].

Click **Next >>** to continue.

AQ12a.

In a typical week, how often do you use your [INSERT SQ06 QUOTA LABEL]?

(Please select one)

- [1] Less than once a week
- [2] 1-3 times a week
- [3] 4-6 times a week
- [4] Once a day
- [5] More than once a day

AQ12b.

What form of detergent do you typically use?

(Please select one)

- [1] Tab (pressed powder)



- [2] Pod or Gel (encased liquid and powder)



- [3] Liquid



- [4] Powder



AQ13a.

Do you (or your household members) typically do a pre-cleaning/rinse of dishes before loading them into the [INSERT SQ06 QUOTA LABEL]?

(Please select one)

- [1] Yes, we typically scrape off excess food before loading into the dishwasher (not using water from the faucet at the kitchen sink)
- [2] Yes, we typically do a pre-rinse before loading into the dishwasher (using water from the faucet at the kitchen sink)
- [3] No, we typically do not do a pre-cleaning/rinse before loading into the dishwasher

AQ13b.

Do you ever re-run your [INSERT SQ06 QUOTA LABEL] load due to it not fully cleaning the dishes?

(Please select one)

- [1] Yes, sometimes
- [2] Yes, but rarely
- [3] No

AQ13c. [ASK ONLY IF AQ13b=1]

In a typical week, how often do you have to rerun your [INSERT SQ06 QUOTA LABEL] load due to it not cleaning the dishes fully?
(Please select one)

- [1] Less than once a week
- [2] 1-3 times a week
- [3] 4-6 times a week
- [4] Once a day
- [5] More than once a day

AQ14.

Have you ever needed to repair your dishwasher (either current or a previous one)? (Please select all that apply)

- [1] Yes, it was covered through the warranty
- [2] Yes, we were able to repair on our own
- [3] Yes, we had to hire someone for the repair
- [4] Yes, the manufacturer support had to fix the repair
- [5] No, I have never had to repair a dishwasher [exclusive]

AQ14a. [ASK IF AQ14=1,2,3, or 4]

What was the age of your dishwasher when a repair was required? (Please select one)

- [1] 0-2 years
- [2] 3-4 years
- [3] 5-7 years
- [4] 8-10 years
- [5] More than 10 years
- [6] Don't know/not sure

AQ14b. [ASK IF AQ14=2, 3, or 4]

How much did the repair cost?
(Please select one)

- [1] Under \$50
- [2] \$50 to \$100
- [3] \$101 to \$200
- [4] Over \$200
- [5] Don't know/not sure

AQ15.

What is your overall satisfaction with your most recently purchased [INSERT SQ06 QUOTA LABEL] in your primary home?

Please use a scale of 1 to 5, where 1 is 'Completely Dissatisfied' and 5 is 'Completely Satisfied'.

(Please select one per row)

	[1] 1=Completely Dissatisfied	[2] 2=Somewhat Dissatisfied	[3] 3=Neither Satisfied nor Dissatisfied	[4] 4=Somewhat Satisfied	[5] 5= Completely Satisfied

[1] Most recently purchased [INSERT SQ06 QUOTA LABEL]	O	O	O	O	O
--	---	---	---	---	---

ASEMAP™ Trade-off Exercise (10 mins)

Thank you for your responses so far. In this section, you will see a list of attributes that might be important to you in **choosing a dishwasher for your home**. We will ask you to rate the importance of these attributes.

PLEASE NOTE THAT THIS SECTION MUST BE COMPLETED IN ONE SITTING. YOU WILL NOT BE ALLOWED TO RETURN BACK TO THE QUESTIONNAIRE IF YOU LOG OUT DURING THIS SECTION.

If you need to pause and return later, please do so before starting this section. This section will take approximately 10 minutes to complete.

For your reference, please review the following definitions of some attributes that you may see in the next section.

GLOSSARY

[INSERT GLOSSARY]

Click **Next >>** to continue.

ATTITUDES (5 mins)

DQ01a.

Please rate your level of agreement with the statements below on a scale of 1 to 5, where 1= “Completely Disagree” and 5 = “Completely Agree”.

(Please select one per row)

	[1] 1= Completely Disagree	[2] 2 = Somewhat Disagree	[3] 3 = Neither agree nor disagree	[4] 4 = Somewhat Agree	[5] 5 = Completely Agree
Refer to list below	O	O	O	O	O

[RANDOMIZE]

A#	Theme	Attitude Label
1	Price Conscious	I want a product that is affordably priced with no unnecessary bells and whistles
2	Price Conscious	The products with promotional prices are most attractive to me
3	Energy efficiency	Energy Guide information and ENERGY STAR® label play a significant role in my product purchasing decisions

4	Energy efficiency	I am willing to pay more money upfront for a product that saves on electricity/gas/water costs over the lifetime of the product
5	Environment friendly	While I am in favor of protecting the environment, other product aspects take priority for me when deciding on a purchase
6	First mover	Among my peers, I am usually the first to try out new products
7	Selection criteria	Product appearance is of great importance to me
8	Selection criteria	I like to have the same brand for all my appliances
9	Selection criteria	I think brands reflect the reliability and performance of appliances
10	Purchasing habit	I always do my research by looking at consumer reviews and product ratings before buying an appliance
11	Purchasing habit	I prefer to purchase a new appliance instead of repairing the broken one
12	Imitator	I usually try out new products if I see that they are working well for my peers

DQ01b.

Please rate your level of agreement with the statements below on a scale of 1 to 5, where 1= “Completely Disagree” and 5 = “Completely Agree”.

(Please select one per row)

	[1] 1= Completely Disagree	[2] 2 = Somewhat Disagree	[3] 3 = Neither agree nor disagree	[4] 4 = Somewhat Agree	[5] 5 = Completely Agree
Refer to list below	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

[RANDOMIZE]

A#	Theme	Attitude Label
15	Selection criteria	If I don't have any space constraints, I would purchase a dishwasher with bigger capacity.
20	DISHWASHER specific	I will only buy a dishwasher that matches my other appliances (in style, color, etc.)
21		
22	DISHWASHER specific	I like to have the same brand for all my appliances
23	DISHWASHER specific	I prefer to purchase a dishwasher with the same tray and rack configuration as my old one

DEMOGRAPHICS (3 mins)

FQ02. Do you have solar panels installed on your primary home to generate electricity?

(Please select one)

- [1] Yes
[2] No

[3] Don't know/not sure

FQ04. Who is your current electricity provider for your primary home?

(Please enter provider in the text box below)

_____ [OE TEXTBOX]

FQ05. Thinking about the last year, what was your average monthly electric bill?

(Please select one)

- [1] Less than \$25
 - [2] \$25-50
 - [3] \$51 - \$100
 - [4] \$101 - \$150
 - [5] \$151 - \$200
 - [6] \$201 - \$250
 - [7] \$251 - \$300
 - [8] \$301 - \$400
 - [9] \$401 - \$500
 - [10] More than \$500
 - [11] Don't know/not sure
 - [99] Prefer not to answer [exclusive]
-

FQ06. When was your house built?

(Please select one)

- [1] 2018
 - [2] 2015-2017
 - [3] 2010-2014
 - [4] 2000-2019
 - [5] 1990-1999
 - [6] 1980-1989
 - [7] 1970-1979
 - [8] 1960-1969
 - [9] 1950-1959
 - [10] Before 1950
 - [11] Don't know/not sure
-

FQ07. Approximately, what is the size (square footage) of your primary home?

(Please select one)

- [1] Less than or equal to 600 sq. ft.
- [2] 601 sq. ft. - 1,000 sq. ft.
- [3] 1,001 sq. ft. - 2,000 sq. ft.
- [4] 2,001 sq. ft. - 3,000 sq. ft.
- [5] 3,001 sq. ft. - 4,000 sq. ft.

- [6] 4,001 sq. ft. - 5,000 sq. ft.
- [7] More than 5,000 sq. ft .
- [8] Don't know/not sure

FQ08. Who currently resides in your household with you?

(Please select all that apply)

- [1] Significant other/Spouse/Partner
- [2] Children
- [3] Other relatives (extended family)
- [4] Roommates (non-family members)
- [5] Other_____
- [6] No one other than me [EXCLUSIVE]
- [99] Prefer not to answer [EXCLUSIVE]

FQ09. How many household members (including you) lives in your home in the following age ranges?

	# of members
[1] Less than or equal to 5 years old	
[2] Between 6 and 17 years old	
[3] Between 18 and 64 years old	
[4] 65 or older	

[99] Prefer not to answer [EXCLUSIVE]

FQ11. Which of the following best describes your current employment status?

(Please select one)

- [1] Employed full-time (30+ hours/week)
- [2] Employed part-time (less than 30 hours/week)
- [3] Stay at home worker without salary
- [4] Student
- [5] Retired
- [6] Business owner
- [7] Other
- [99] Prefer not to answer

This completes the survey. We appreciate you taking the time to share your opinion.

APPENDIX B. FULL ASEMAP RESULTS

Additional ASEMAP queries were conducted by OSG as shown in Figures B1 through B15 below. Results are shown for all products, as well as for the different dishwasher product categories. The base sample for all of these figures are all respondents in the complete sample.

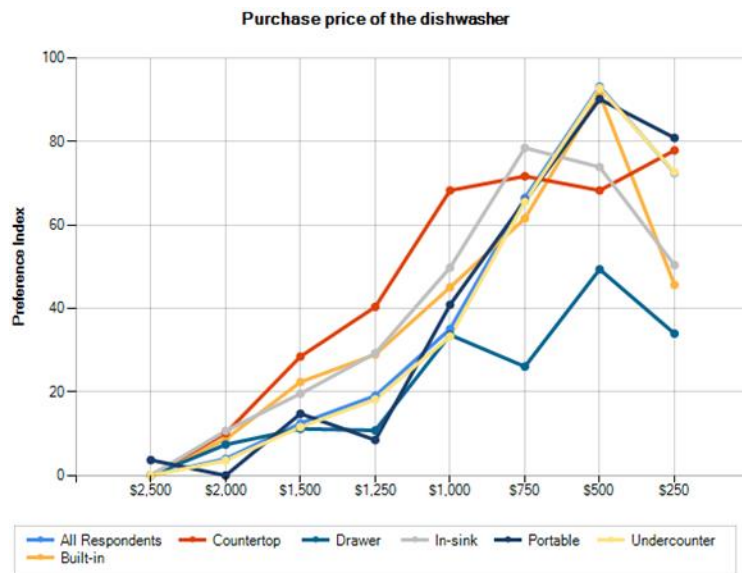


Figure B1. Consumer preference for dishwasher purchase price by dishwasher type

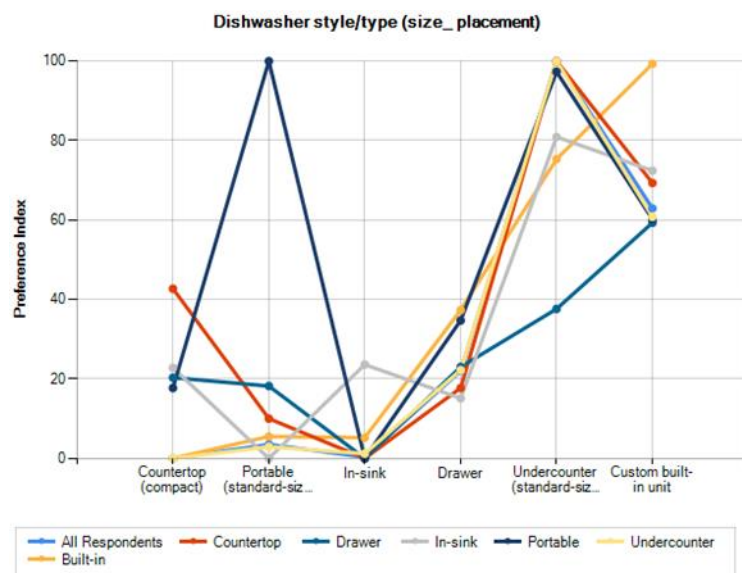


Figure B2. Consumer preference for dishwasher style/type by dishwasher type

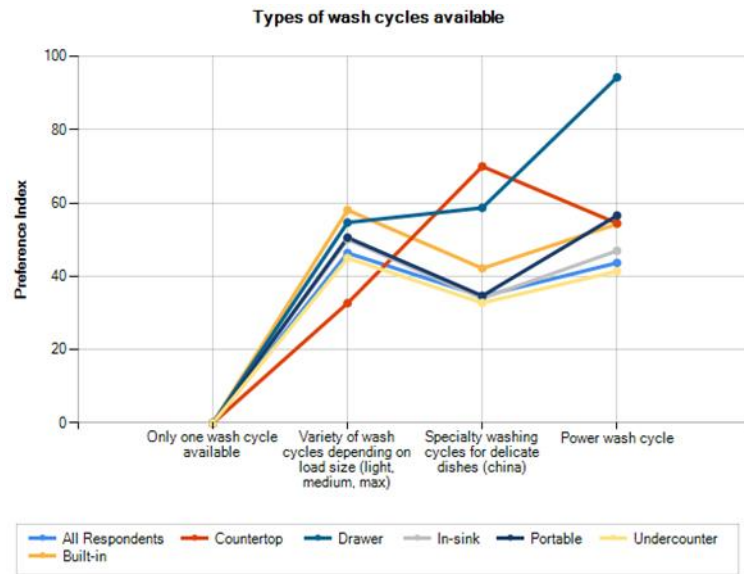


Figure B4. Consumer preference for wash cycles by dishwasher type

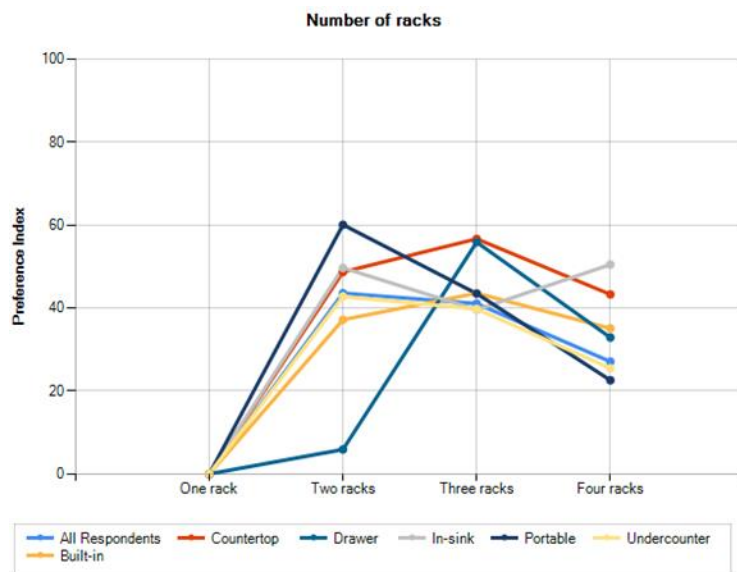


Figure B5. Consumer preference for number of racks by dishwasher type

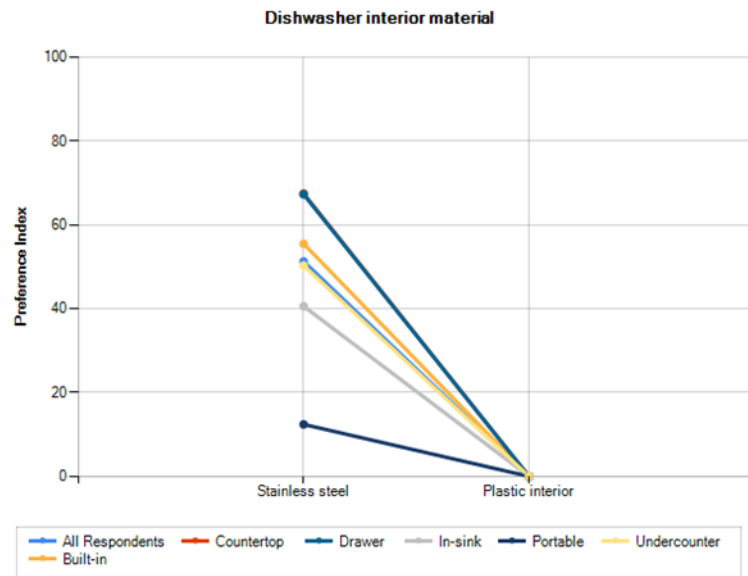


Figure B6. Consumer preference for interior material by dishwasher type

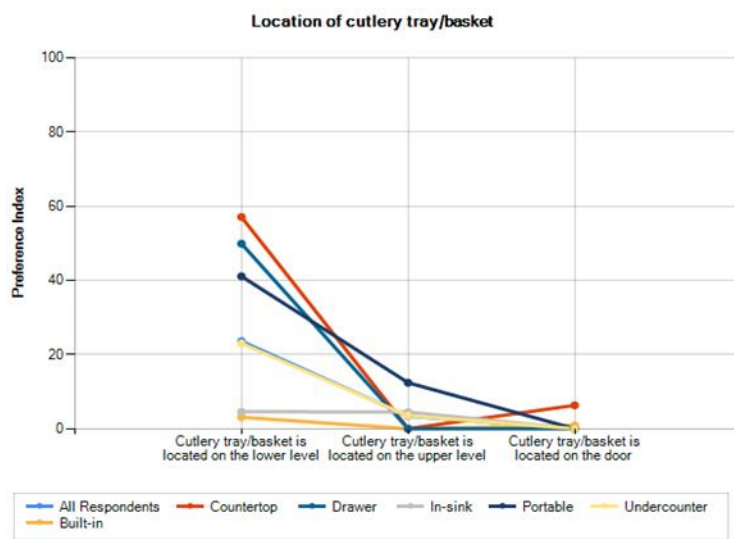


Figure B7. Consumer preference for cutler tray location by dishwasher type

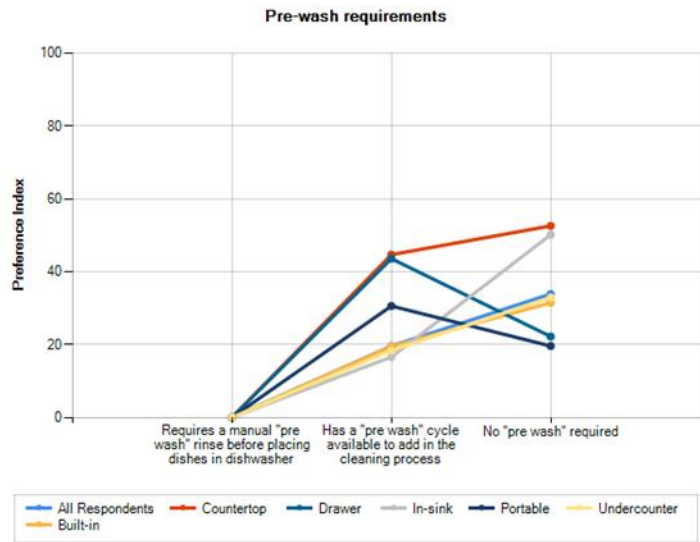


Figure B8. Consumer preference for pre-wash requirements by dishwasher type

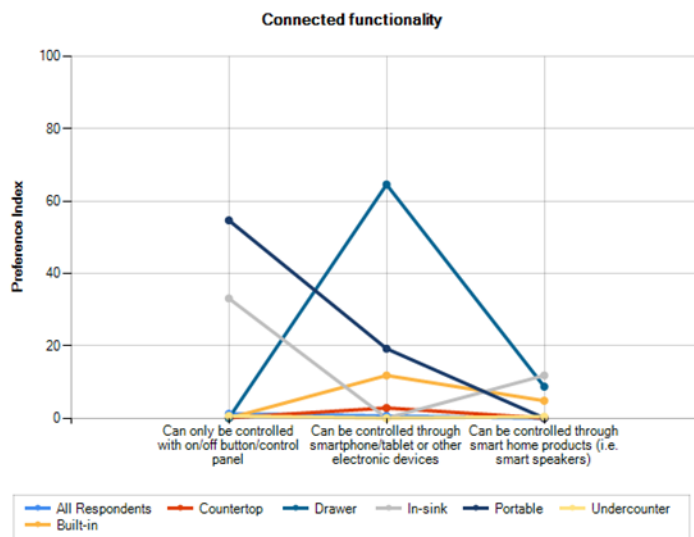


Figure B9. Consumer preference for connected functionality by dishwasher type

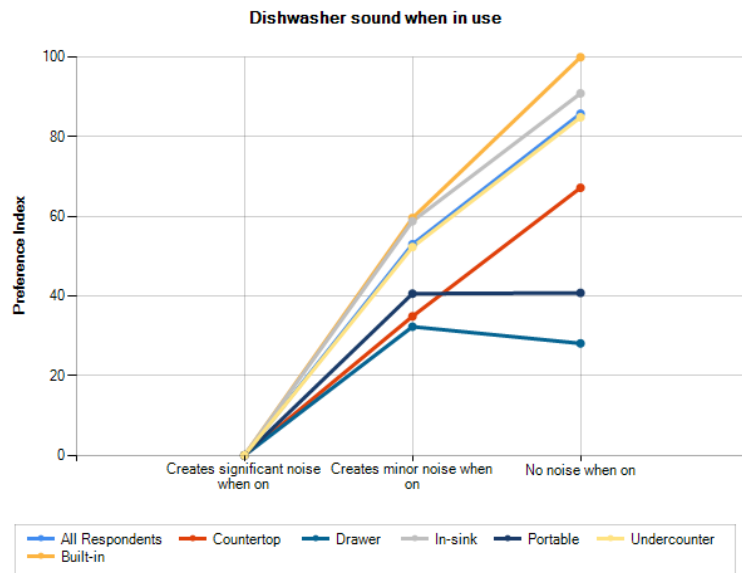


Figure B10. Consumer preference for noise level by dishwasher type

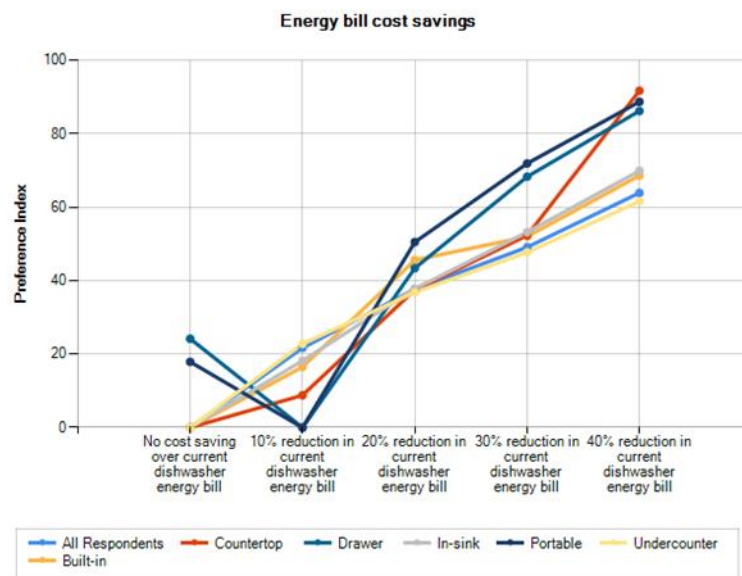


Figure B11. Consumer preference for energy cost savings by dishwasher type

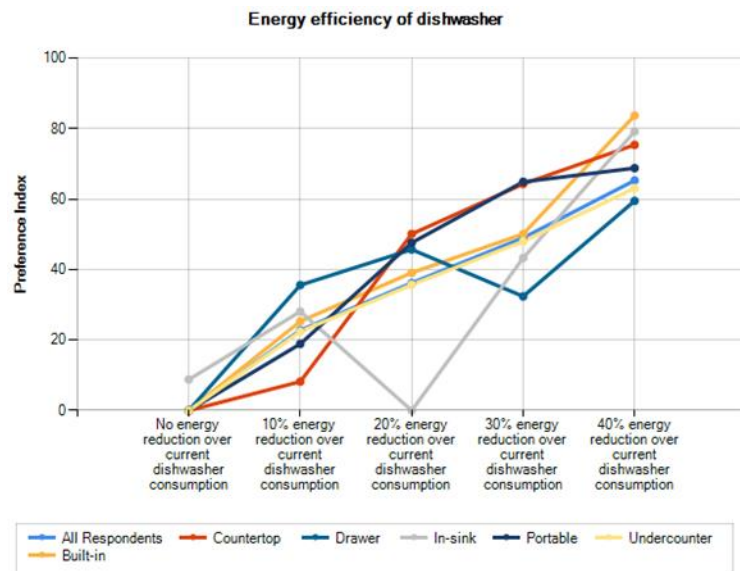


Figure B.11. Consumer preference for dishwasher noise level by dishwasher type

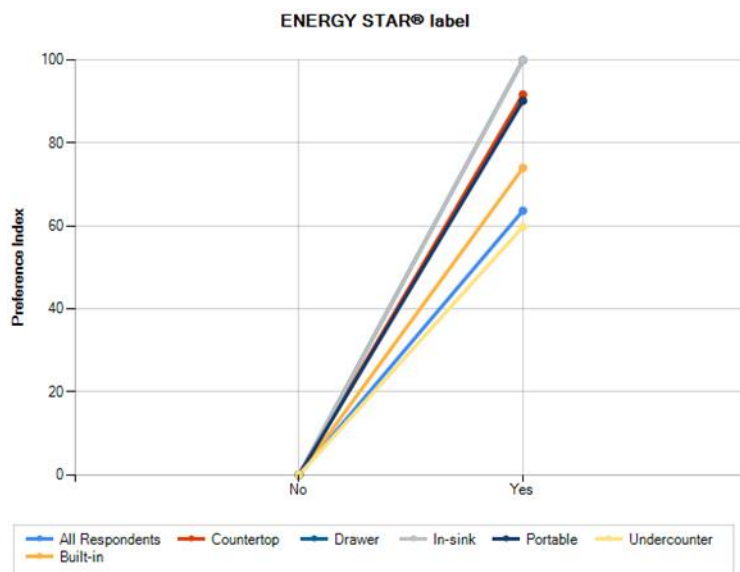


Figure B12. Consumer preference for ENERGY STAR® products by dishwasher type

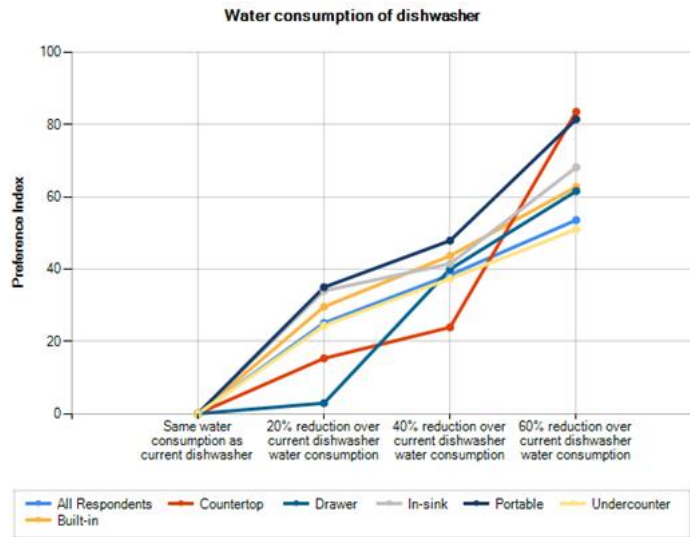


Figure B13. Consumer preference for ENERGY STAR® products by dishwasher type

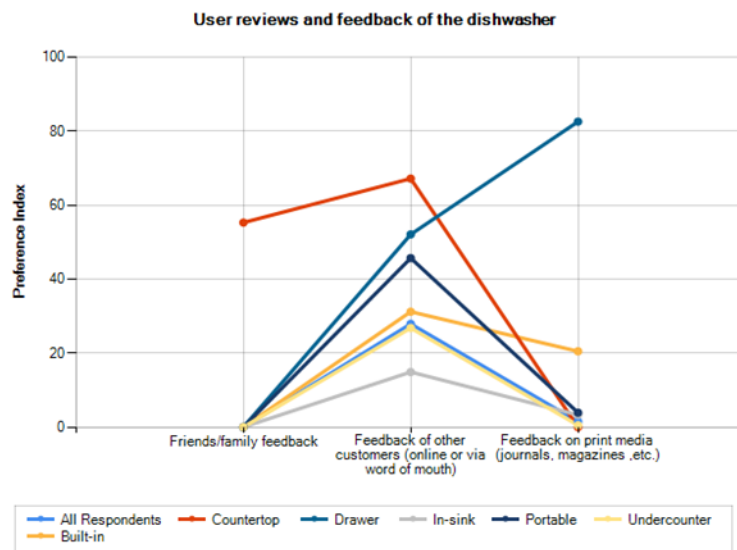


Figure B14. Consumer preference based on user reviews and feedback by dishwasher type

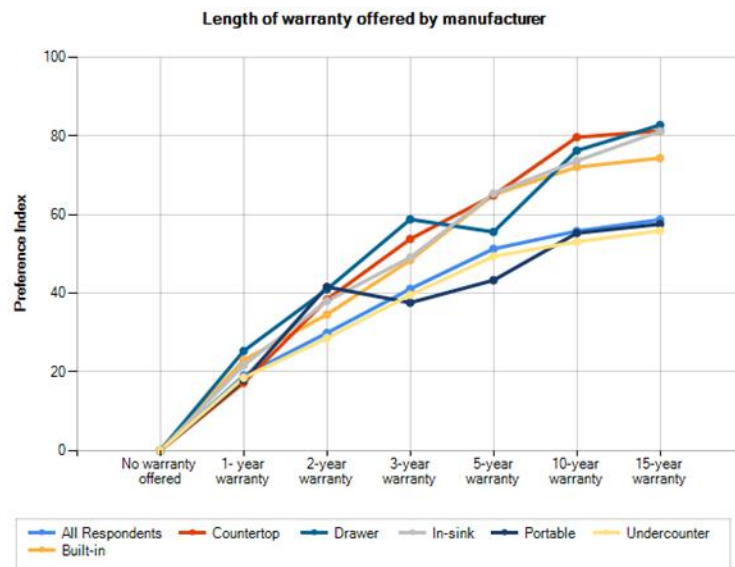


Figure B15. Consumer preference based on manufacturer warranty length

APPENDIX C. GENERAL SURVEY RESULTS

Table C1 through Table C11 below show additional survey results. The full text of the questions can be found in Appendix A by referring to the question number (e.g. AQ06).

Table C1. Dishwasher purchase with other appliances

AQ04b: Dishwasher Purchased Along with Other Appliances	N = 1201
Yes, I purchased it together with other home appliances as a bundle	29%
No, I purchased only the dishwasher	71%

Table C2. Differences in dishwasher size between current and previous dishwasher

AQ06: Difference Recent & Previous Dishwasher Size	N=991
Yes	90%
No	7%
Don't know/not sure	4%

Table C3. Satisfaction of dishwasher purchase

AQ15: Overall Satisfaction (T2B)**	N=1201
Satisfaction with dishwasher purchase	91%

Table C4. Familiarity with ENERGY STAR® label

AQ08: Familiarity with ENERGY STAR® Label	N=1201
Yes, I saw the ENERGY STAR® label and took it into account in my purchase decision	57%
Yes, I saw the ENERGY STAR® label, but didn't take it into account in my purchase decision	27%
Yes, I saw the ENERGY STAR® label, but didn't know what it meant	11%
No, I didn't come across any ENERGY STAR® labels	5%
No, I've never heard of ENERGY STAR®	0%

Table C5. Factors for purchasing non- ENERGY STAR® dishwasher

AQ08b: Factors for Purchasing Non-Energy Star® Labeled Model	N=21
ENERGY STAR® models are more expensive	72%
Other product features are more important to me	20%
Other	12%

*Base: Respondents who took the ENERGY STAR® label into account and did not purchase an ENERGY STAR® labelled product, though not all respondents in that subgroup provided a response.

Table C6. Familiarity with Energy Guide label

AQ08d: Familiarity with EnergyGuide Label	N=1201
Yes, I looked at EnergyGuide labels and compared energy consumption of different choices/options	58%
I didn't pay attention to, or notice, EnergyGuide labels while looking at models	23%
Yes, I saw EnergyGuide labels and didn't know what they meant	19%

Table C7. Smart home technologies used in the home

AQ09a: Smart Home Technologies Used	N=1201
Smart speakers/displays	41%
I do not have any smart home technologies in my home	39%
Smart thermostats	30%
Smart light bulbs	22%
Smart appliances	17%
Smart plugs/power strips	16%

Table C8. Smart function usage

AQ11: Usage of Dishwasher's Smart Functions	N=167
I use it to lock and unlock the dishwasher door	61%
I use it to start and stop cycles	59%
I use it to manage the settings of the dishwasher	49%
I use it to get updates on when the cycle is complete	48%
I use it to get updates on when my dishwasher is low on detergent or rinse aid	29%
I use it to monitor energy use and delay cycle time to off-peak hours to save energy consumption	20%
Other	0%

Table C9. Detergent used

AQ12b: Form of Detergent Used	N=1201
Pod or Gel (encased liquid and powder)	55%
Liquid	21%
Tab (pressed powder)	18%
Powder	7%

Table C10. Purchase attitudes for appliances

DQ01a: General Attitudes (T2B)**	N = 1201
I always do my research by looking at consumer reviews and product ratings before buying an appliance	78%
I think brands reflect the reliability and performance of appliances	73%
Product appearance is of great importance to me	72%
The products with promotional prices are most attractive to me	67%
I am willing to pay more money upfront for a product that saves on electricity/gas/water costs over the lifetime of the product	67%
While I am in favor of protecting the environment, other product aspects take priority for me when deciding on a purchase	61%
I want a product that is affordably priced with no unnecessary bells and whistles	61%
Energy Guide information and ENERGY STAR® label play a significant role in my product purchasing decisions	59%
I prefer to purchase a new appliance instead of repairing the broken one	54%
I usually try out new products if I see that they are working well for my peers	39%
I like to have the same brand for all my appliances	37%
Among my peers, I am usually the first to try out new products	25%

*Base: All respondents in the complete sample

** T2B indicates the percentage of respondents who selected the option somewhat agree and completely agree.

Table C11. Purchase attitudes for dishwashers

DQ01b: Product Specific Attitudes (T2B)**	N=1201
I will only buy a dishwasher that matches my other appliances	69%
If I don't have any space constraints, I would purchase a dishwasher with bigger capacity	45%
I prefer to purchase a dishwasher with the same tray and rack configuration as my old one	37%
I like to have the same brand for all my appliances	37%

*Base: All respondents in the complete sample

** T2B indicates the percentage of respondents who selected the option somewhat agree and completely agree.

REFERENCES

¹ US Department of Energy - Energy Information Administration, Residential Energy Consumption Survey: 2015 Public Use Data Files, 2015. <http://www.eia.doe.gov/emeu/recs/recspubuse15/pubuse15.html> (Last accessed March 31, 2021)

² US Department of Housing and Urban Development. American Housing Survey 2019. <https://www.census.gov/programs-surveys/ahs.html> (Last accessed March 31, 2021)

³ Optimal Strategies Group (OSG). 2011. “PG&E Lighting Conjoint Study ASEMAP.” Pacific Gas and Electric Company (PG&E).

⁴ Netzer, Oded and Srinivasan, V. Seenu, Adaptive Self-Explication of Multi-Attribute Preferences (Winter 2011). Journal of Marketing Research, Vol. 48, No. 1, pp. 140-156, 2009 , Columbia Business School Research Paper No. 12-18, Available at SSRN: <https://ssrn.com/abstract=1960352>

⁵ US Department of Energy. Compliance Certification Database. https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*. (Last accessed August 5, 2021).